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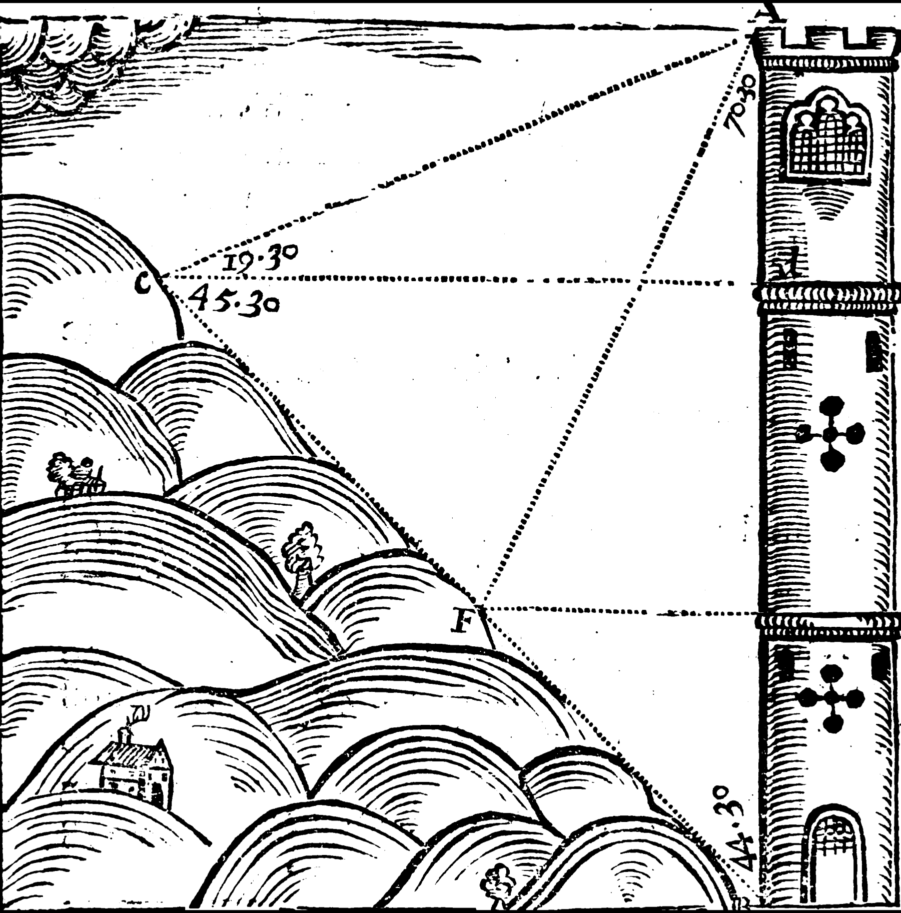

Geodæsia

John Love

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GEODÆSIA:

OR, THE

ART

OF

SURVEYING

AND

Meaſuring of LAND

Made EASY.

SHEWING,

By Plain and Practical RULES, how to Survey, Protract, Caſt up, Reduce or Divide any Piece of Land whatſoever; with New TABLES for the Eaſe of the Surveyor in Reducing the Meaſures of Land.

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By *JOHN LOVE.*

The FIFTH EDITION.

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THE PREFACE TO THE READER.

WHAT would be more ridiculous, than for me to go about to praiſe an Art that all Mankind know they cannot live peaceably without? It is near hand as ancient (no doubt on't) as the World: For how could Men ſet down to plant, without knowing ſome Diſtinction and Bounds of their Land? But (Neceſſity being the Mother of Invention) we find the *Egyptians*, by reaſon of the *Nyle*'s overflowing, which either waſh'd away all their Bound-

Marks, or cover'd them over with Mud, brought this meaſuring of Land firſt into an Art, and honoured much the Profeſſors of it. The great Uſefulneſs, as well as the pleaſant and delightful Study, and wholſome Exerciſe of which, tempted ſo many to apply themſelves thereto, that at length in *Egypt* (as in *Bermudas*) every Ruſtick could meaſure his own Land.

From *Egypt*, this Art was brought into *Greece* by *Thales*, and was for a long time called *Geometry*; but that being too comprehenſive a Name for the Menſuration of a Superficies only, it was afterwards called *Geodæſia*; and what Honour it ſtill has continued to have among the Antients, needs no better Proof than *Plato*'s ἀγεωμετρήτος ȣ̓δεὶς εἰσίτω. And not only *Plato*, but moſt, if not all the learned Men of thoſe Times, refuſed to admit any into their Schools, that had not been firſt entred in the *Mathematicks*, eſpecially *Geometry* and *Arithmetick*. And we may ſee, the great Monuments of Learning built on theſe Foundations continuing unſhaken to this Day, ſufficiently demonſtrate the Wiſdom of the Deſigners in chuſing *Geometry* for their Ground-Plot.

Since which, the *Romans* have had ſuch an Opinion of this Sort of Learning, that they concluded that Man to be incapable of commanding a Legion, that had not at leaſt ſo much *Geometry* in him, as to know how to meaſure a Field. Nor did they indeed either reſpect Prieſt or Phyſician, that had not ſome Inſight in the *Mathematicks.*

Nor can we complain of any Failure of Reſpect given to this Excellent Science by our modern Worthies, many Noblemen, Clergymen, and Gentlemen affecting the Study thereof: So that we may ſafely ſay, none but unadviſed Men ever did, or do now ſpeak evil of it.

Beſides the many Profits this Art brings to Man, it is a Study ſo pleaſant, and affords ſuch wholeſome and innocent Exerciſe, that we ſeldom find a Man that has once entred himſelf into the Study of *Geometry* or *Geodæſia,* can ever after wholly lay it aſide: So natural is it to the Minds of Men, ſo pleaſingly inſinuating, that the *Pythagoreans* thought the Mathematicks to be only a Reminiſcience, or calling again to mind things formerly learned.

But no longer to light Candles to ſee the Sun by, let me come to my Buſineſs, which is to ſpeak ſomething concerning the following Book; and if you ask, Why I write a Book of this nature, ſince we have ſo many very good ones already in our own Language? I anſwer, Becauſe I cannot find in thoſe Books many things, of great conſequence, to be underſtood by the Surveyor. I have ſeen young Men in *America* often nonplus'd ſo, that their Books would not help them forward; particularly in *Carolina*, about laying out Lands, when a certain Quantity of Acres has been given to be laid out five or ſix times as broad as long. This I know is to be laugh'd at by a Mathematician; yet to ſuch as have no more of this Learning, than to know how to meaſure a Field, it ſeems a difficult Queſtion: And to what Book already printed of Surveying ſhall they repair to be reſolved?

Alſo concerning the *Extraction of the Square Root*; I wonder that it has been ſo much neglected by the Teachers of this Art, it being a Rule of ſuch abſolute Neceſſity for the Surveyor to be acquainted with. I have taught it here as plainly as I could deviſe,

viſe, and that according to the old Way, verily believing it to be the beſt, uſing fewer Figures, and once well learned, charging leſs the Memory than the other Way.

Moreover, the Sounding the Entrance of a River or Harbour is a Matter of great Import, not only to Seamen, but to all ſuch as Seamen live by; I have therefore done my Endeavour to teach the young Artiſt how to do it, and draw a fair Draught thereof.

Many more Things have I added, ſuch as I thought to be new, and wanting; for which I refer you to the Book itſelf.

As for the Method, I have choſe that which I thought to be the eaſieſt for a Learner; adviſing him firſt to learn ſome Arithmetick, and after, teaching him how to extract the Square Root. But I would not have any *Neophyte* diſcouraged, if he find the firſt Chapter too hard for him; for let him rather skip it, and go to the ſecond and third Chapters, which he will find ſo eaſy and delightful, that I am perſuaded he will be encouraged to conquer the Difficulty of learning that one Rule in the firſt Chapter.

From *Arithmetick*, I have proceeded on to teach ſo much *Geometry* as the Art of *Sur-*

veying requires. In the next place, I have ſhewed by what Meaſures Land is ſurveyed, and made ſeveral Tables for the reducing one Sort of Meaſure into another.

From which I come to the Deſcription of Inſtruments, and how to uſe them; wherein I have chiefly inſiſted on the Semicircle, it being the beſt that I know of.

The Sixth Chapter teacheth how to apply all the foregoing Matters together, in the practical ſurveying of any Field, Wood, *&c.* divers Ways, by divers Inſtruments; and how to lay down the ſame upon Paper. Alſo at the End of this Chapter I have largely inſiſted on, and by new and eaſy Ways, taught ſurveying by the Chain only.

The Seventh, Eighth, Ninth, Tenth and Eleventh Chapters, teach how to caſt up the Contents of any Plot of Land; how to lay out new Lands; how to ſurvey a Manor, County or Country; alſo, how to reduce and divide Lands, *cum multis aliis.*

The Twelfth Chapter conſiſts wholly of *Trigonometry.*

The Thirteenth Chapter is of Heights and Diſtances, including, amongſt other things, how to make a Map of a River or Harbour.

Alſo how to convey Water from a Spring-head to any appointed Place, or the like.

Laſtly, at the End of the Book, I have a Table of Northing or Southing, Eaſting or Weſting; or (if you pleaſe to call it ſo) A Table of Difference of Latitude and Departure from the Meridian, with Directions for the Uſe thereof. Alſo a Table of Sines and Tangents, and a Table of Logarithms.

I have taken Example from Mr. *Holwell*, to make the Table of *Sines* and *Tangents* but to every fifth Minute, that being nigh enough in all Senſe and Reaſon for the Surveyor's Uſe; for there is no Man, with the beſt Inſtrument that ever was yet made, can take an Angle in the Field nigher, if ſo nigh, as to five Minutes.

All which I commend to the ingenious Reader, wiſhing he may find Benefit thereby, and deſiring his favourable Reception thereof accordingly. I conclude,

READER,

Your Humble Servant,

J. L.

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BOOKS

BOOKS *printed for* W. INNYS.

1. THE Gentleman's Steward and Tenants of Manors inſtructed. Containing rational, eaſy, and familiar Rules and Tables for finding the Value of Eſtates of Freehold, Copyhold, or Leaſehold, as well on Lives as for Years abſolute, *&c.* With an Enquiry into the Nature of the annual Diſburſements, Precariouſneſs of the Tenure, and Caſualties, that Eſtates in Fields or Houſes, or both, are charged with, or liable to; and how they are to be accounted for in the Valuation. Wherein the Errors and Abſurdities of all the common Methods of Valuation, and the Diſadvantages thence accruing, ſometimes to the Landlord and ſometimes to the Tenant, are juſtly expos'd. The Tables for valuing Eſtates on Lives being founded on Dr. *Halley*'s Hypotheſis, and calculated by the Method laid down by Mr. *Abr. de Moivre*, to 4, 5, 6, 7, and 8 *per Cent.* To which is added, An Appendix, containing the Deſcription and Uſe of an Inſtrument for diſcovering the Number of Feet contained in any Timber-Trees before they are cut down, by Inſpection only. By *John Richards* of *Exon.* 8*vo.* 1730.

2. An Analytick Treatiſe of Conic Sections, and their Uſe for reſolving of Equations in determinate and indeterminate Problems; being the poſthumous Work of the Marquis *de l'Hoſpital.* 4*to.* 1723.

3. The Method of Fluxions, both direct and inverſe: The former being a Tranſlation from the celebrated Marquis *de l'Hoſpital*'s *Analyſe des Infiniments Petits*; and the latter ſupplied by the Tranſlator, *E. Stone*, F. R. S. 2 Vols. 8*vo.* 1730.

4. A new Mathematical Dictionary: Wherein is contained, not only the Explanation of the bare Terms, but likewiſe an Hiſtory of the Riſe, Progreſs, State, Properties, *&c.* of Things, both in pure Mathematicks and natural Philoſophy, ſo far as it comes under a Mathematical Conſideration. By *E. Stone*, F. R. S. The ſecond Edition, with large Additions. 8*vo.* 1743.

GEODÆSIA:

OR, THE

ART

OF

Meaſuring Land, &c.

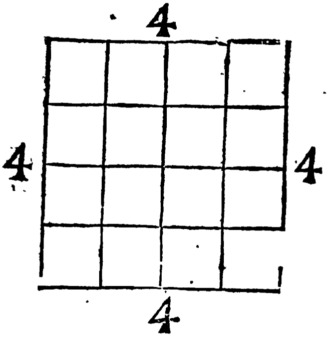
CHAP. I.

Of ARITHMETICK.

IT is very neceſſary for him that intends to be an Artiſt in the Meaſuring of Land, to begin with Arithmetick, as the Ground-work and Foundation of all Arts and Sciences Mathematical; and at leaſt not to be ignorant of the five firſt and principal Rules thereof, *viz: Numeration*, *Addition*, *Subtraction*, *Multiplication* and *Diviſion*: Which ſuppoſing every Perſon that applies himſelf to the Study of this Art to be ſkilled in; or if not, referring him to Books or Maſters (every where to be found) to learn: I ſhall name a ſixth Rule, as neceſſary (if not more) to be underſtood by the Learner; which is the Extraction of the Square Root; without which (though ſeldom mentioned by Surveyors in their Writings) a Man can never attain to a competent Knowledge in the Art: I ſhall not therefore think it unworthy my Pains (tho' perhaps other Men have better done it before me) to ſhew you eaſily and briefly how to do it.

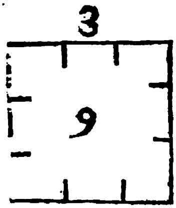
How to Extract the Square Root.

In the firſt place, it is convenient to tell you what the Square Root is: It is to find out of any Number propounded a leſſer Number, which leſſer Number being multiplied in itſelf, may produce the Number propounded. As for Example: Suppoſe 81 be a Number given me, I ſay 9 is the Root of it; becauſe 9 multiplied in itſelf, *viz.* 9 times 9 is 81. Now 8 could not be the Root, for 8 times 8 is but 64: nor could 10, for 10 times 10 is 100; therefore, I ſay, 9 muſt needs be the Root, becauſe multiplied in itſelf, it makes neither more nor leſs, but juſt the Number propounded, *viz.* 81.



Again: Suppoſe 16 be the Number given, I ſay the Root of it is 4, becauſe 4 multiplied in itſelf makes 16. For your better underſtanding ſee this Figure, which is a great Square, containing 16 little Squares; any Side of which great Square contains 4 little Squares: which is called the Square Root.

Or, Suppoſe a plain ſquare Figure be given you as this in the Margin, and it be required of you to divide it into 9 ſmall Squares; your Buſineſs is to know into how many Parts to divide any one of the Side Lines, which here muſt be into 3, and that is the Root required. But how to do this readily is the thing I am now going to teach you. The Roots of all ſquare Numbers under 100, you have in your Multiplication Table; however, ſince it is good for you to keep them in your Mind, take this ſmall Table of them.



Roots	1	2	3	4	5	6	7	8	9
Squares	1	4	9	16	25	36	49	64	81

Here you ſee the Root of 25 is 5, the Root of 64 is 8, and ſo of the reſt.

So far as 100 in whole Numbers, your Memory will ſerve you to find the Root; but if the Number propounded, whoſe Root you are to ſearch out, exceed 100, then put a Point over the firſt Figure on the Right-hand, which is the Place of Units, and ſo proceeding to the Left-hand, miſs the ſecond Figure, and put a Point over the third; then miſſing the fourth, point the fifth; and ſo (if there be ever ſo many Figures in the Number) proceed on to the End, pointing every other Figure, as you may ſee here, and ſo many Points as there are, of ſo many Figures your Root will conſiſt, which is very material to remember: Then begin at the firſt Figure on the Left-hand that has a Point over it, which will always be the firſt or ſecond Figure, and ſearch out the Root

$$\dot{1}2\dot{3}4\dot{5}6\dot{7}$$

of that one Figure, or both joined together if there be two; and when you have found it, or the nigheſt leſs to it, which you may eaſily do by the Table above, or your own Memory, draw a little crooked Line, as in Diviſion, and there ſet it down. For Example: Let 144 be the Number whoſe Root I am to find; I ſet it down, and prick the Figures thus: Then going to the firſt Figure on the Left-hand that has a Prick over it, which is 1, and ſee what the Root of it is, which is 1 alſo; I therefore draw a crooked Line, as in the Margin, and ſet down 1 in the Quotient; then if 1 admitted of any Multiplication, I ſhould multiply it by itſelf; but ſince once 1 is but 1, I ſubtract it out of the firſt prick'd Figure on the Left-hand, and there remains 0; ſo that I cancel that firſt Figure, as having wholly done with it: If any thing had remained after the Subtraction, I ſhould have put the Remainder over it. The next thing to be done, is to double what is already in the Quotient, which makes 2; which 2 I write down under the next Figure, *viz.* 4, which has no Point over it, and then ſee how oft I can have 2 in 4: Anſwer, twice. I therefore ſet down 2 in the Quotient, and 2 likewiſe under the next pointed Figure, which in this Example is 4; then that 22 which ſtands under the 44 muſt be multiplied by the 2 in the Quotient, whoſe Product is 44; which ſubtracted out of 44, there remains 0. But you may multiply and ſubtract together thus, twice 2 is 4, which I take out of 4, and there remains 0; then I cancel the firſt 4 and 2 to the Left-hand, as having done with them; then again, twice 2 is 4, which taken out of 4 leaves 0; and then I cancel the

$$\begin{array}{lll} \dot{\cancel{1}} & \cancel{4} & \dot{\cancel{4}}\,(12 \\ & \cancel{2} & \cancel{2} \end{array}$$

the laſt 4 and 2, and the Queſtion is anſwered; for there is 12 in the Quotient, which is the Root of 144, which may eaſily be proved by multiplying 12 by 12.

$$\begin{array}{l} \dot{\cancel{5}}4\dot{7}5\dot{6}(2 \\ \cancel{2} \end{array}$$

$$\begin{array}{l} 1 \\ \cancel{1}\cancel{2}8 \\ \dot{\cancel{5}}\cancel{4}\dot{\cancel{7}}5\dot{6}(23 \\ \cancel{2}\cancel{4}\cancel{3} \end{array}$$

Take another Example: Let the Sum be 54756; firſt ſee what the Root of 5 is, which is 2, and place it in the Quotient, and under the firſt pointed Figure both, as you ſee here; then ſay 2 times 2 is 4, which taken out of 5, there remains 1; and ſo have you done with the firſt Point. Next double the Quotient, which makes 4, and place it as you ſee here, under the Figure void of a Point; then ſee how many times 4 you can have in 14, anſwer 3 times; which 3 place both in the Quotient, and under the next pointed Figure, which is 7; then multiply and ſubtract, ſaying 3 times 4 is 12, which taken out of 14 leaves 2; which 2 write over the 4, and cancel both the 4 and the 1, as you do in Diviſion: And three times 3 is 9, which taken out of 27, reſts 18; which write over head, and cancel what Figures you have done with, no otherwiſe than in Diviſion, and ſo have you done with the firſt two Points. Now for the third pointed Figure, or if there were never ſo many more of them, they are done altogether as the ſecond; *viz.* Double again your Quotient, it makes 46; which put down as you ſee in the Margin, always obſerving this Rule, That the laſt Figure of the doubled Quotient, I mean that in the place of Units, ſtand under the next, void of Points: And thoſe of your Left-hand of him, *viz.* in the place of Tens or Hundreds, in order before him, as you do in Diviſion, as you may ſee here. Then proceed, and ſay, How many times 46 can I have in 185, or rather how many times 4 in 18? Here Eſſay, as you do in Diviſion, and ſee if you can have it four times, remembring the 4 that muſt be put down under the pointed Figure; and when you find you can have it four times, write it down in the Quotient, and alſo under your laſt pointed Figure; then ſay four times 4 is 16, out of 18 there reſts 2, which write down, and cancel the 18 and 4. Again, four times 6 is 24, out of 25 reſts 1; which put down, and cancel the 2, 5, and 6. Again, four times 4 is 16, out of 16 reſts 0; and ſo have you done, and find the Root to be 234.

$$\begin{array}{l}
1 \\
\cancel{1}\cancel{2}8 \\
\dot{\cancel{5}}\cancel{4}\dot{\cancel{7}}5\dot{6}(23 \\
\cancel{3}\cancel{4}\cancel{3}6 \\
4
\end{array}$$

$$\begin{array}{l}
\cancel{1}\cancel{2} \\
\cancel{1}\cancel{2}8\cancel{1}0 \\
\dot{\cancel{5}}\cancel{4}\dot{\cancel{7}}\cancel{5}\dot{\cancel{6}}(234 \\
\cancel{2}\cancel{4}\cancel{3}\cancel{6}\cancel{4} \\
\cancel{4}
\end{array}$$

I'll add but one Example more for your Practice. Let the Number, whoſe Root is requir'd, be $1\dot{2}3\dot{4}5\dot{6}7\dot{8}$; ſee the working of it.

But in this you ſee there is a Fraction remains, and ſo there will be in moſt Numbers, for we ſeldom happen upon a Number exactly ſquare: The fractional Part muſt therefore thus be taken; Before you begin to extract, add to your Number given two Cyphers, if you deſire to know but to the tenth Part of an Unit; but if to an hundredth Part add four Cyphers, if to a thouſandth Part of an Unit add ſix Cyphers, and then work as before, as if it was all one entire Number, and look how many Points were placed over the Number firſt given, ſo many Places of Integers will be in the Root; the reſt of the

$$\begin{array}{l}
\cancel{2}\ \ 0 \\
\cancel{3}\ \cancel{8}45\cancel{4}9 \\
\cancel{1}\dot{\cancel{2}}\cancel{3}\dot{\cancel{4}}\cancel{5}\dot{\cancel{6}}\cancel{7}\dot{8}(3513 \\
\cancel{3}\cancel{6}\cancel{5}\cancel{0}\cancel{1}\cancel{2}\cancel{3} \\
\cancel{7}\cancel{7}\cancel{0}
\end{array}$$

the Root towards the Right-hand will be the Numerator of a decimal Fraction. For Example: Let 143 be the Number given to be extracted; and to know the decimal Fraction as near as to the hundredth Part of an Unit, I write it down as before, annexing four Cyphers to the end of it, as you ſee hereunder; and after having wrought it, there comes out in the Quotient 11.95; but becauſe I had but two Points over the firſt Number given, *viz.* 143, I therefore at the end of two Figures in the Quotient put a Point, which parts the whole Number from the Fraction; that 11 on the Left-hand being Integers, and the 95 on the right Centeſms of an Unit, which you may either write as above, or thus, 11$\frac{95}{100}$, if you pleaſe.

~~2~~19
~~22~~0 1430000
~~434~~7
~~022394~~5
~~1430000~~ (11.95
~~212985~~
~~223~~

There are other Ways taught by Arithmeticians for finding out the Square Root of any Number; but I know no way ſo conciſe as this, and, after a little Practice, ſo eaſy and ready, or to be wrought with as few Figures. To do it indeed by the Logarithms, or Artificial Numbers, is very eaſy and pleaſant; but Surveyors have not always Books of Logarithms about them, when they have occaſion to extract the Square Root: However, I will briefly ſhew you how to do it, and give you one Example thereof.

When you have any Number given whoſe Square Root you deſire, ſeek for the given Number in the Table of Logarithms under the Title Numbers; and right againſt it, under the Title Logarithms, you will find the Logarithm of the ſaid Number, the half of which is the Logarithm of the Root deſired: Which half ſeek for under the Title Logarithm, and right againſt it under the Title Number you will find the Root.

EXAMPLE.

Let 625 be the Number whoſe Root is deſired: Firſt I ſeek for it under the Title Numbers, and right againſt it I find this *Log.* 2,795880, which I divide by 2, or take the half of it as you ſee: } *Half.* 1,397640. And finding that half under the Title Log. right againſt it is 25, the Root deſired. See the ſame done by the former way with leſs trouble.

$\cancel{2}\cancel{2}(0$
$\cancel{6}\cancel{2}\cancel{5}(25$ Root.
$\cancel{2}\cancel{4}\cancel{5}$

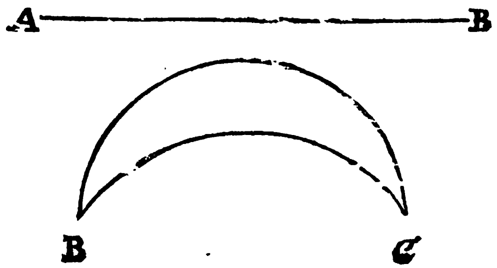
CHAP.

CHAP. II.

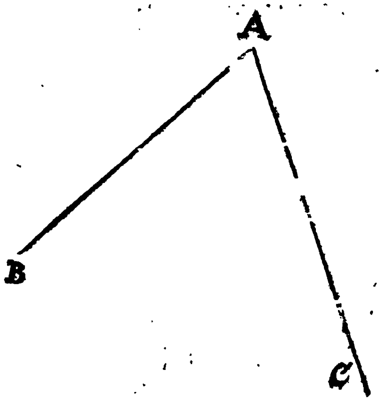
Geometrical DEFINITIONS.

A Point is that which hath neither Length nor Breadth, the leaſt thing which can be imagined, and which cannot be divided, commonly marked as a full Stop in Writings, thus (.)

A Line has Length, but no Breadth nor Thickneſs, and is made by many Points joined together in Length; of which there are two Sorts, *viz.* Strait and Crooked. As, A B is a ſtrait Line, B C two crooked Lines.

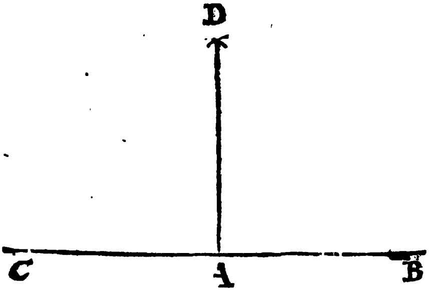


An Angle is the meeting of two Lines in a Point; provided the two Lines ſo meeting do not make one ſtrait Line, as the Line A B, and the Line A C, meeting together in the Point A, make the Angle B A C.



Of which Right-lined Angles there are three Sorts, *viz.* Right-angled, Acute, Obtuſe.

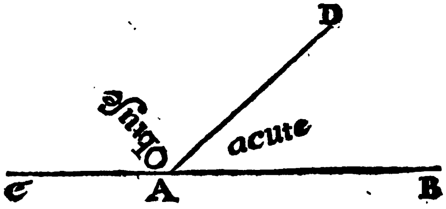
When a Line falleth perpendicularly upon another Line, it maketh two Right Angles.



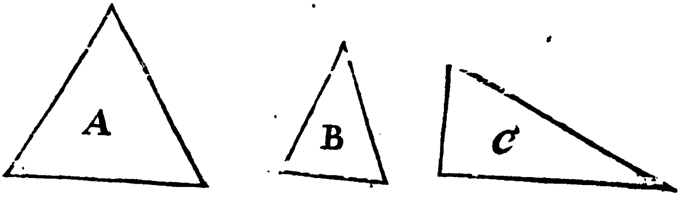
EXAMPLE.

Let CAB be a Right Line, DA a Line perpendicular to it, that is to ſay, neither leaning towards B nor C, but exactly upright; then are both the Angles at A, *viz.* DAB, and DAC, Right Angles;

gles; and contain each juſt 90 Degrees, or the fourth Part of a Circle; but if the Line D A had not been perpendicular, but had leaned towards B, then had D A C been an Obtuſe Angle, or greater than a Right Angle; and D A B an Acute Angle, or leſſer than a Right Angle, as you ſee hereunder.



All Figures contained under three Sides are called Triangles, as A, B, C.



Where note, The Triangle A hath three equal Sides, and is called an Equilateral Triangle.

The Triangle B hath two Sides equal, and the third unequal, and is called an Iſoſceles Triangle.

The Triangle C hath three unequal Sides, and is called a Scalenum.

Of four ſided Figures there are theſe Sorts:

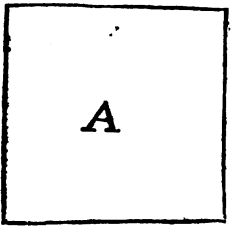
Firſt, A Square, whoſe Sides are all equal, and Angles right, as A.

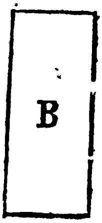
Secondly, A long Square, or Parallelogram, whoſe oppoſite Sides are equal, and Angles right, as B.

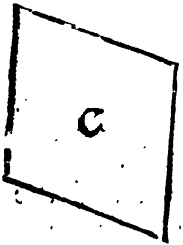
Thirdly, A Rhombus, whoſe Sides are all equal, but no Angle right, as C.

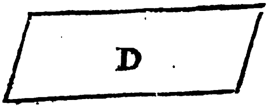
Fourthly, A Rhomboides, whoſe oppoſite Sides only are equal, and no right Angles, as D.

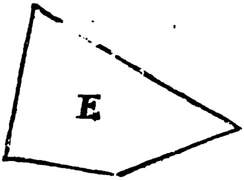
All other four ſided Figures are called Trapezia, as E.



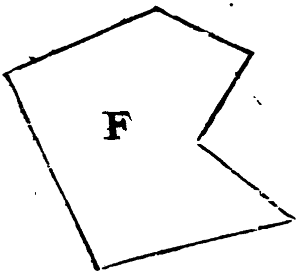




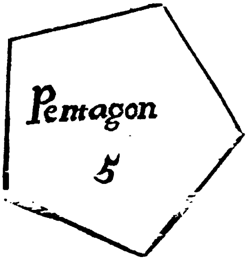


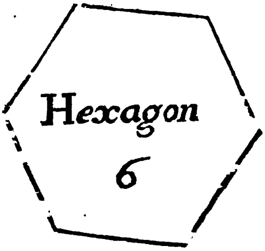


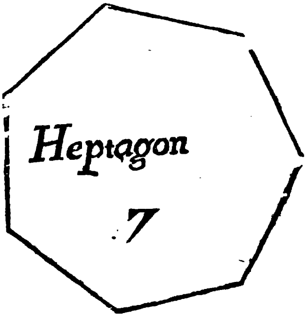
Other Figures that are contained under 5, 6, 7, or more Sides, I call Irregular, as F, *&c.* except

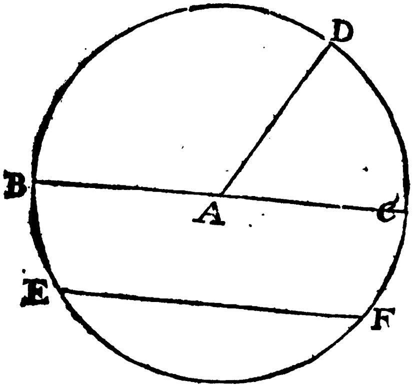


ſuch as are made by dividing the Circumference of a Circle into any Number of equal Parts; for then they are regular Figures, having all their Sides and Angles equal; and are called according to the Number of right Lines the Circle is divided into, or more properly according to the Number of Angles they contain, as a Pentagon, Hexagon, Heptagon, Octogon, *&c.* Which in plain *Engliſh* is no more than a Figure of five or ſix, ſeven or eight Angles; which Angles are all equal one to another, and their Sides conſequently all of the ſame Length. And thus (though I mention no more than 8) the Circumference of the Circle may be divided into as many Parts as you pleaſe; and the regular Figures ariſing out of ſuch Diviſions, are called according to the Number of Parts the Circle is divided into. See, for your better underſtanding, theſe two or three following.









A Circle is a Figure determined with one endleſs Line, as A. Which Line is called the Circumference of the Circle, in the Middle whereof is a Prick or Point, by which the Circle is deſcribed, which is called the Center, from which Point or Center all ſtrait Lines drawn to the Circumference are equal, or of the ſame Length, as AB, AC, AD.

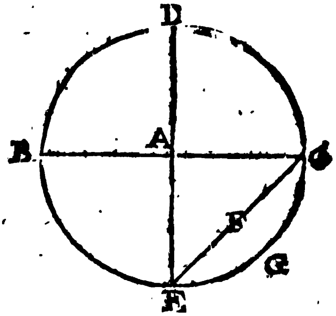
The Diameter of a Circle is a Line, which paſſing through the Center cuts the Circle into two equal Parts, or the longeſt ſtrait Line that can be made in any Circle, as B C.

The Semidiameter is the half of the above-mentioned Line, as A B, A C, or A D, either of which is called a Semidiameter.

A Chord is any Line ſhorter than the Diameter, which paſſeth from one Part of the Circumference to another, as E C.

A Semicircle is the half of a Circle, as B D C, or B E C.

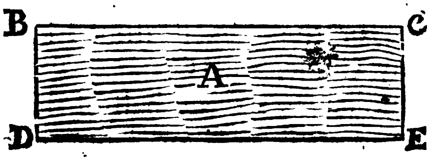
A Quadrant is the fourth Part of a Circle, made by two Diameters perpendicularly interſecting each other, as A B D, A D C, A B E, A E C, either of which is a Quadrant, or the fourth Part of a Circle.



A Section, Segment, or Part of a Circle, is a Piece of the Circle cut off by a Chord Line, and is greater or leſs than a Semicircle, as E F C G is a Segment of the Circle E B D C G, likewiſe E B D C F is the greater Segment of the ſame Circle.

A Superficies is that which hath both Length and Breadth, but no Thickneſs; whoſe Bounds are Lines, as A is a Superficies or Plane contained in theſe Lines, B C, D E, B D, C E, which hath Length from B to C, and Breadth from B to C, but no Thickneſs.

When

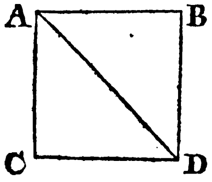


When theſe bounding Lines are meaſured, and the Content of the Superficies caſt up, the Reſult is called the Area or ſuperficial Content of that Figure.

EXAMPLE.

Suppoſe the Line BC to be twelve Foot in Length, and the Line BD to be four Foot long, they multiplied together make 48; therefore I ſay 48 ſquare-Feet is the Area or ſuperficial Content of that Figure.

When two Lines are in every Part equidiſtant from each other, they are called Parallel Lines, as the Lines AB and CD; which tho' produc'd to never
A————————B ſo great a Length, would
C————————D come no nearer to each other, much leſs meet.



A Diagonal Line is a Line running thro' a ſquare Figure, dividing it into two Triangles, beginning at one Angle of the Square and proceeding to the oppoſite Angle. In the Square ABCD, AD is the Diagonal Line.

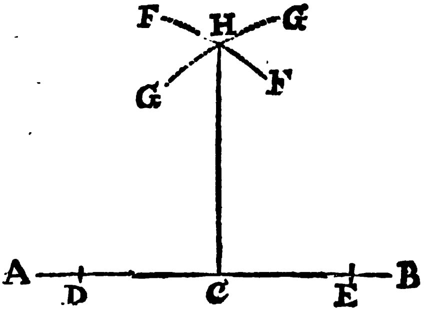
CHAP. III.

Geometrical PROBLEMS.

PROB. I.

How to make a Line perpendicular to a Line given.

THE Line given is A B, and at the Point C, it is required to erect a Line which ſhall be perpendicular to A B.

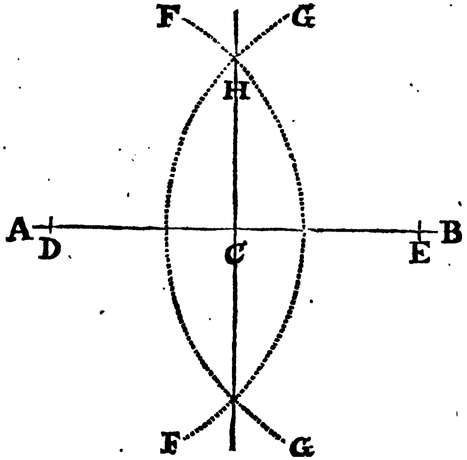


Open your Compaſſes to any convenient Wideneſs, and ſetting one Foot of them in the Point C, with the other make a Mark upon the Line at E, and alſo at D; then taking off your Compaſſes, open them a little wider than before, and ſetting one Foot in the Point D, with the other deſcribe the Arch F F; then without altering your Compaſſes, ſet one Foot in the Point E, and with the other deſcribe the Arch G G.

Laſtly,

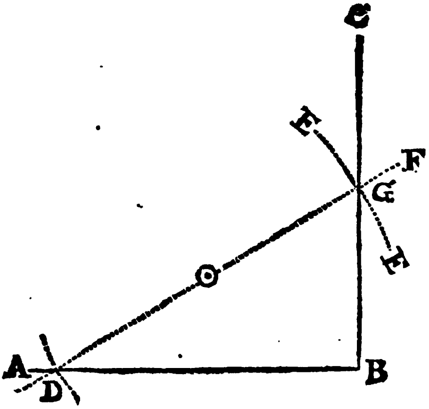
Laſtly, Lay your Ruler to the Point C, and the Interſection of the two Arches G G and F F, which is at H, and drawing the Line H C, you have your Deſire, H C being perpendicular to A B.

See it here done again after the very ſame manner, but perhaps plainer for your Underſtanding.



PROB. II.

How to raiſe a Perpendicular upon the End of a Line.

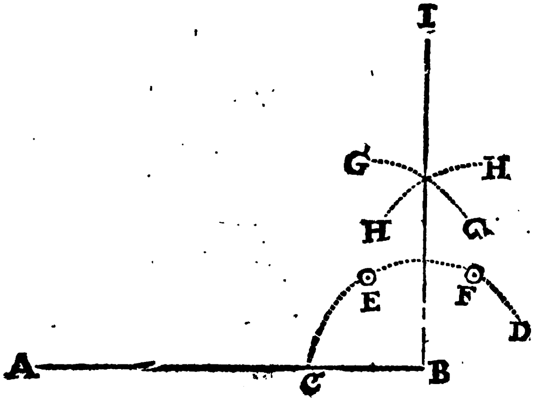


A B is the Line given, and at B it is required to erect the Perpendicular B C.

Open your Compaſſes to an ordinary Extent, and ſetting one Foot in the Point B, let the other fall at adventure, no matter where in reaſon, as at the Point ⊙; then without altering the Extent of the Compaſſes, ſet one Foot in the Point ⊙, and with the other croſs the Line A B as at D: Alſo on the other ſide deſcribe the Arch E E, then laying your Ruler to D and ⊙, draw the prick'd Line D ⊙ F: Laſtly, from the Point B, you began at, through the Interſection at G, draw the Line B G C, which is perpendicular to A B.

Another Way, I think more eaſy, 'though indeed almoſt the ſame.

Let A B be the given Line, B I the Perpendicular required.

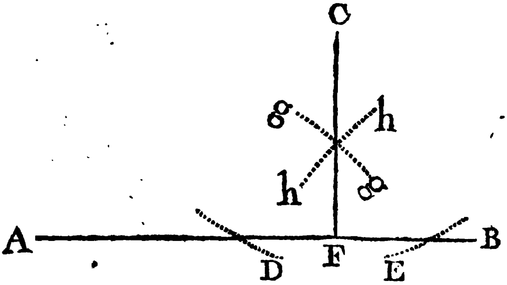


Set one Foot of your Compaſſes in B, and with the other at any ordinary Extent, deſcribe the Arch C E F D; then keeping your Compaſſes at the ſame Extent, ſet one Foot in C, and make a Mark upon the Arch at E; and keeping one Foot in E, make another Mark at F; then with any Extent ſet one Foot in E, and with the other deſcribe the Arch G G: Alſo ſetting one Point in F, make the Arch H H, then drawing a Line through the Interſection of the Arches G and H, to the Point firſt propoſed.

PROB. III.

How from a Point aſſigned, to let fall a Perpendicular upon a Line given.

The Line given is A B, the Point is at C, from which it is deſired to draw a Line down to A B, that may be perpendicular to it.

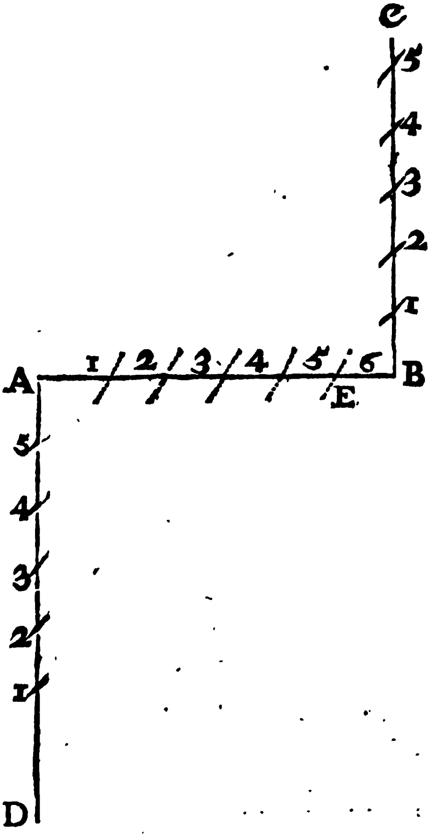


Firſt, Setting one Foot of your Compaſſes in the Point C, with the other make a Mark upon the Line A B as at D, and alſo at E; then opening your Compaſſes wider, or ſhutting them cloſer, either will do;

ſet one Foot in the Point of Interſection at D; and with the other deſcribe the Arch *g g*; the like do at E, for the Arch *h h*. Laſtly, From the Point aſſigned, thro' the Point of Interſection of the two Arches, *gg* and *h h*, draw the perpendicular Line CF. This is no more but the firſt Problem reverſed: The ſame you may do by the ſecond Problem, *viz.* Let fall a Perpendicular nigh the End of a given Line.

PROB. IV.

How to divide a Line into any Number of equal Parts.



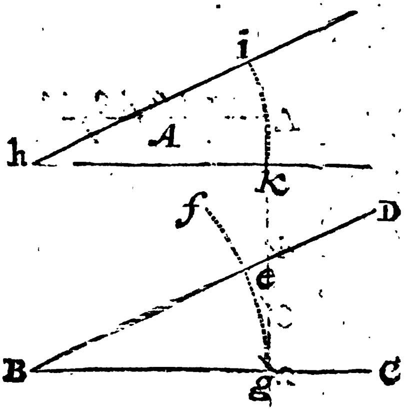
A B is a Line given, and it is requir'd to divide it into 6 equal Parts.

Make at the Point B a Line perpendicular to A B, as B C: Do the ſame at A, the contrary way, as you ſee here; open your Compaſſes to any convenient Wideneſs, and upon the Lines BC and AD, mark out five equal Parts; for it muſt be always one leſs than the Number you intend to divide the Line into: which Parts you may number, as you ſee here, thoſe upon one Line one way, and the other the contrary way; then laying your Ruler from No. 1. on the Line BC, to No. 1. on the Line AD, it will interſect the Line AB at E, which you may mark with your Pen, and the Diſtance between B and E is one ſixth part of the Line; ſo proceed on till you come to No. 5. and then you will find that you have divided the given Line into ſix equal Parts, as required.

PROB. V.

How to make an Angle equal to any other Angle given.

The Angle given is A, and you are deſired to make one equal to it.

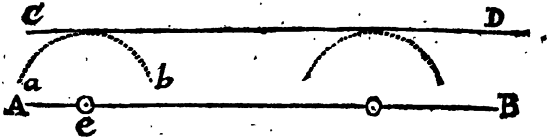


Draw the right Line BC, then going to the Angle A, ſet one Foot of your Compaſſes in the Point *h*, and with the other at what Diſtance you pleaſe, deſcribe the Arch I K, then without altering the Extent of the Compaſſes, ſet one Foot in B, and draw the like Arch, as *fg*; after that, meaſure with your Compaſſes how far it is from K to I, and the ſame Diſtance ſet down upon the Arch from *g* towards *f*, which will fall at C; after draw the Line B C D, and you have done.

PROB. VI.

How to make Lines parallel to each other.

A B is a Line given, and it is required to make a Line parallel unto it.

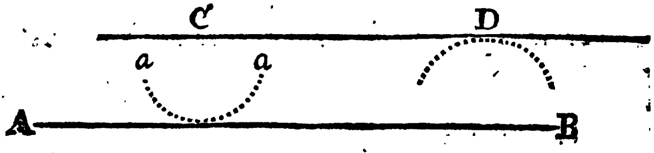


Set one Foot of your Compaſſes at or near the End of your given Line, as at C, and with the other deſcribe the Arch *a b*; do the ſame near the other End of the ſame Line, and through the utmoſt Convex of thoſe two Arches draw the Line C D, it is the Parallel required.

PROB. VII.

How to make a Line parallel to another Line, which muſt alſo paſs through a Point aſſigned.

Let AB be the given Line, C the Point through which the required parallel Line muſt paſs.



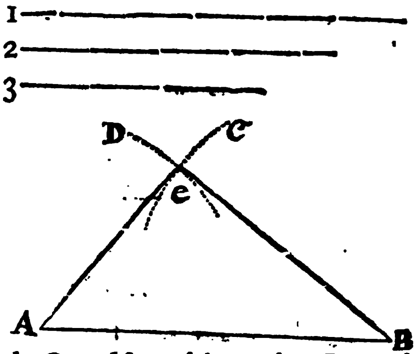
Set one Foot of your Compaſſes in C, and cloſing them ſo that they will juſt touch (and no more) the Line AB, deſcribe the Arch *a a*; with the ſame Extent in any Part of the given Line ſet one Foot, and deſcribe another Arch as at D; then through the aſſigned Point C, and the utmoſt Convex of the laſt Arch, draw the required Line CD, which is parallel to AB, and paſſeth through the Point C.

PROB. VIII.

How to make a Triangle, three Lines being given.

Let the three Lines given be 1, 2, 3; the Queſtion is how to make a Triangle of them.

Take with your Compaſſes the Length of either of the three in this Example: Let it be that No. 1. *viz.* the longeſt, and lay it down as hereunder from A to B; then taking with your Compaſſes the Length of the Line 2, ſet one Foot in B, and make the Arch C; alſo taking the Length of the laſt Line 3, place your Compaſſes at A, and make the Arch D, which will interſect the Arch C, at the Point *e*; from which Point of Interſection draw Lines to A B, which ſhall conſtitute the Triangle A *e* B; the Line A B being equal to the Line No. 1, B *e* to No. 2, A *e* to No. 3.

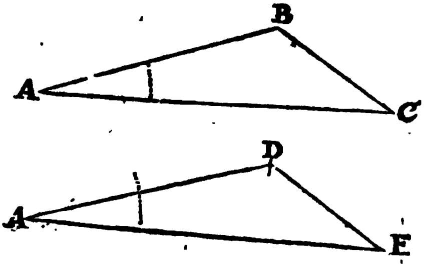


PROB. IX.

How to make a Triangle equal to a Triangle given, and every way in the ſame Proportion.

Firſt make an Angle equal to the Angle at A, as you were taught in *Prob.* 5. Then making the Lines A D and A E equal to A B and A C, draw the Line D E.

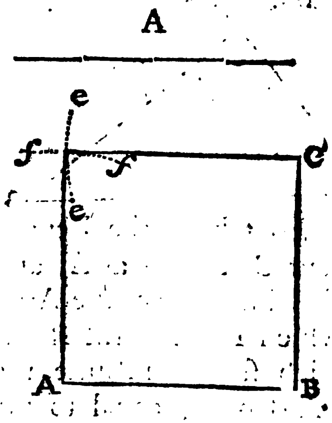
Or otherwiſe you may do it as you were taught in *Prob.* 8.



PROB.

PROB. X.

How to make a Square Figue.



Let A be a Line given, and it is required to make a ſquare Figure, each Side of which ſhall juſt be the Length of the Line A.

Firſt, Lay down the Length of your Line A, as A B.

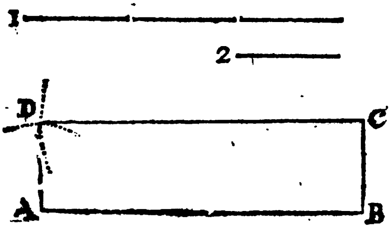
Secondly, Raiſe a Perpendicular of the ſame Length at B.

Thirdly, Take the Length of either of the aforementioned Lines with your Compaſſes, and ſetting one Foot in C deſcribe the Arch *e e*; do the like at A, and deſcribe the Arch *f f*.

Fourthly, Draw Lines from A and C into the Point of Interſection, and the Square is finiſhed.

PROB. XI.

How to make a Parallelogram, or long Square.



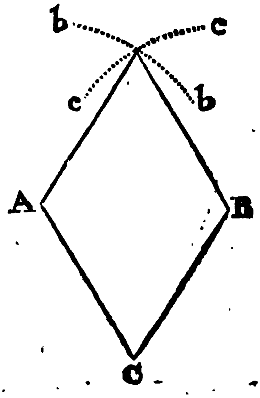
This is much like the former. Admit two Lines be given, as 1, 2, and it is required to make a Parallelogram of them: What a Paa Parallelogram is, you may ſee in the ſecond Chapter of *Definitions*.

Firſt, Lay down your longeſt Line, as AB, upon the End of which erect a perpendicular Line, equal in Length to your ſhorteſt Line; and ſo proceed, as you were taught in the foregoing Problem.

PROB. XII.

How to make a Rhombus.

Firſt, Make an Angle, ſuppoſe ACB, no matter how great or ſmall; but be ſure let the two Lines be of equal Length; then taking with your Compaſſes the Length of one of thoſe two Lines, ſet one Foot in A, and deſcribe the Arch *bb*; alſo ſet one Foot in B, and deſcribe the Arch *cc*. Laſtly, draw Lines, and it is finiſhed. Two Equilateral Triangles is a Rhombus.

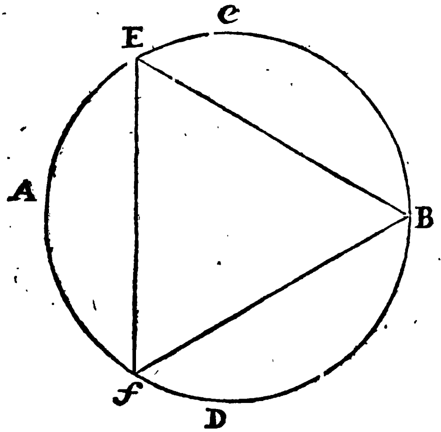


A Rhomboides differs juſt ſo much, and no more from a Rhombus, as a Parallelogram does from a true Square; it is needleſs therefore, I preſume, to ſhew you how to make it.

PROB. XIII.

How to divide a Circle into any Number of equal Parts, not exceeding ten; or otherwiſe how to make the Figures called, Pentagon, Hexagon, Heptagon, Octagon, *&c.*

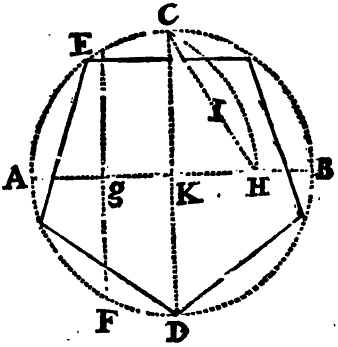
Let ABCD be a Circle, in which is required to be made a Triangle, the greateſt that can be made in that Circle.



Keeping your Compaſſes at the ſame Extent they were at when you made the Circle, ſet one Point of them in any Part of the Circle, as at A, and with the other make a Mark at E and *f*, and draw a Line between E and *f*, which will be one Side of the Triangle.

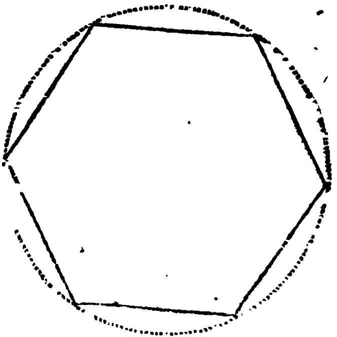
I need not tell you how to make the other two Sides, for it is an Equilateral Triangle, all three Sides being of equal Length.

To make a Pentagon, or Five-ſided Figure.



Draw firſt an obſcure Circle, as A C B D; then draw a Diameter from A to B; make another Diameter perpendicular to the firſt, as C D; then taking with your Compaſſes the Length of the Semidiameter, ſet one Point in A, and make the Marks E F, drawing a Line between them, as you did to make a Triangle. Next, ſet one Point of your Compaſſes in the Interſection at *g*, and extend the other to C, draw the Arch C H: the neareſt Diſtance between C and H, *viz.* the Line C I H, is the Side of a Pentagon, and the greateſt that can be made within that Circle: Which with the ſame Extent of your Compaſſes you may mark out round the Circle, and drawing Lines, the Figure will be finiſhed.

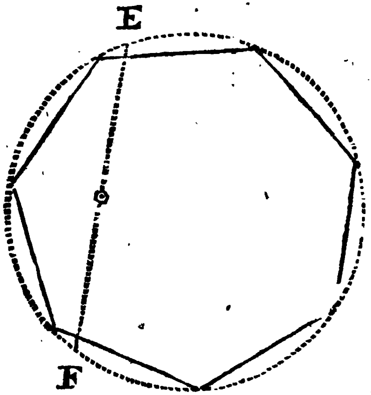
To make a Hexagon or Six-ſided Figure.



Draw an obſcure Circle, as you ſee here, and then without altering the Extent of the Compaſſes, mark out the Hexagon requir'd round the Circle; for the Semidiameter of any Circle is the Side of the greateſt Hexagon that can be made within the ſame Circle.

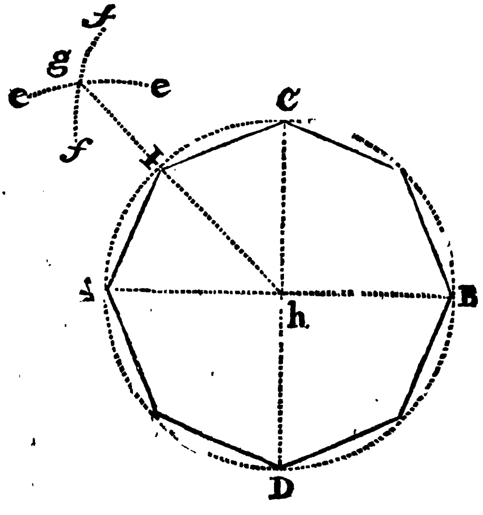
This is the way Coopers uſe to make Heads for their Caſks.

To make a Heptagon, or Figure of Seven equal Sides and Angles.



You muſt begin and proceed, as if you were going to deſcribe a Triangle in a Circle, till you have drawn the Line E F; then taking with your Compaſſes the half of that Line, *viz.* from ⊙ to E, or from ⊙ to F, mark out round the Circle your Heptagon; for the half of the Line E F is one Side of it.

To make an Octogon, commonly called an Eight-ſquare Figure.



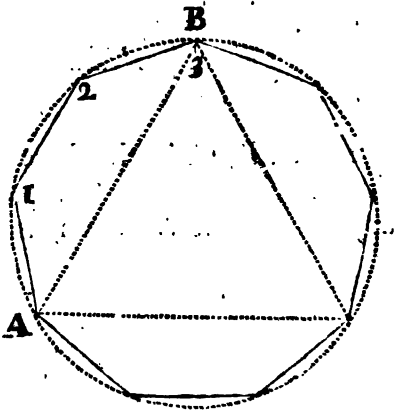
Firſt, Make a Circle.

Secondly, Divide it into four equal Parts by two Diameters, the one perpendicular to the other, as A B and C D.

Thirdly, Set one Foot of the Compaſſes in A, and make the Arch *ee*; alſo with the ſame Extent ſet one Foot in C, and make the Arch *ff*; then thro' the Interſection of the two Arches draw a Line to the Center, *viz.* *g h.*

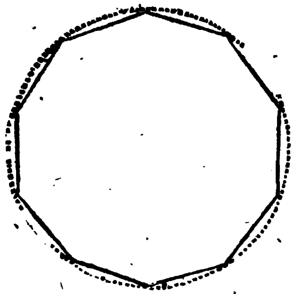
Laſtly, Draw the Line I C or I A, either of which is the Side of an Octagon.

To make a Nonagon.



Firſt, Make a Circle, and a Triangle in it, as you were taught at the Beginning of this Problem. Then divide one third Part of the Circle. As for Example, that A, 1, 2, 3, B, into three equal Parts. Laſtly, draw the Lines A 1, 1, 2, 2 B, *&c.* each of theſe Lines is the Side of a *Nonagon.*

To make a Decagon.

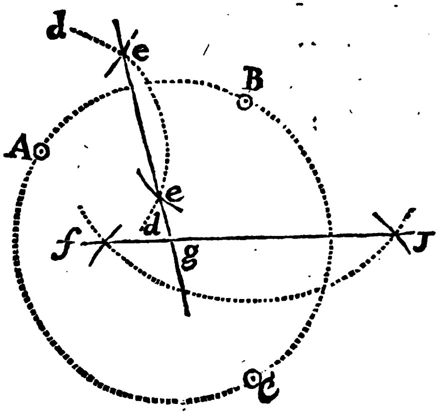


You muſt work altogether as you did in making a *Pentagon:* See the *Pentagon* above, where the Diſtance from the Centre K to the Point at H is the Side of a *Decagon* or Ten-ſided Figure.

PROB. XIV.

Three Points being given: How to make a Circle, whoſe Circumference ſhall paſs through the three given Points, provided the three Points are not in a ſtrait Line.

Let A, B, C, be the three Points given; firſt ſetting one Foot of your Compaſſes in A, open them to any convenient Wideneſs, more than half the Di-



ſtance between A and B, and deſcribe the Arch *d d*; then without altering the Extent, ſet one Point in B, and croſs the firſt Arch at *e* and *e*, through thoſe two Interſections draw the Line *e e*.

The very ſame you muſt do between B and C, and draw the Line *f f*; where thoſe two Lines interſect each other, as at *g*, there is the Centre of the Circle required; therefore ſetting one Foot of your Compaſſes in *g*, extend the other to any of the Points given, and deſcribe the Circle A B C. Note, The Centre of a Triangle is found the ſame way.

PROB. XV.

How to make an Ellipſis, or Oval, ſeveral ways.

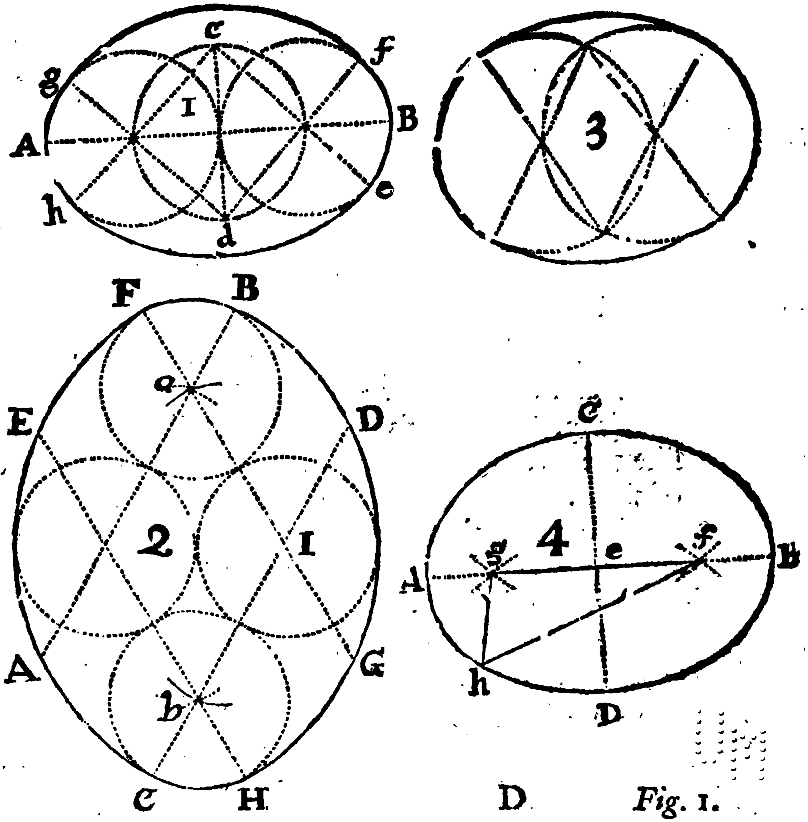


Fig. 1. Make the Circles, whoſe Diameters may be in a ſtrait Line, as A B; croſs that Line with another perpendicular to it at the Centre of the middle Circle, as *c d:* draw the Lines *ce*, *c b*, *dg*, *df*. Set one Foot of the Compaſſes in D, and extend the other to *g*, deſcribing the Part of the Ellipſis *g f*; with the ſame Extent, ſetting one Foot in C, deſcribe the other Part *b e:* the two Ends are made by Parts of the two outermoſt ſmall Circles, as you ſee *fe*, *g b*.

Fig. 2. Draw two ſmall Circles, whoſe Circumferences may only touch each other: Then taking the Diſtance between their Centres, or either of their Diameters, ſet one Foot of your Compaſſes in either of their Centres, as that marked 2, and with the other make an Arch at *a*, alſo at *b*; there moving your Compaſſes to the Centre of the other Circle, croſs the ſaid Arches at *a* and *b*, which Croſſes let be the Centres of two other Circles of equal Bigneſs with the firſt. Then thro' the Centres of all the Circles, draw the Lines A B, C D, E H, F G; which done, place one Foot of the Compaſſes in the Centre of the Circle I, and extend the other to C, deſcribing the Arch of the Ellipſis C E F: The ſame you muſt do at 2, to deſcribe the Part B H, and then is your Ellipſis finiſhed.

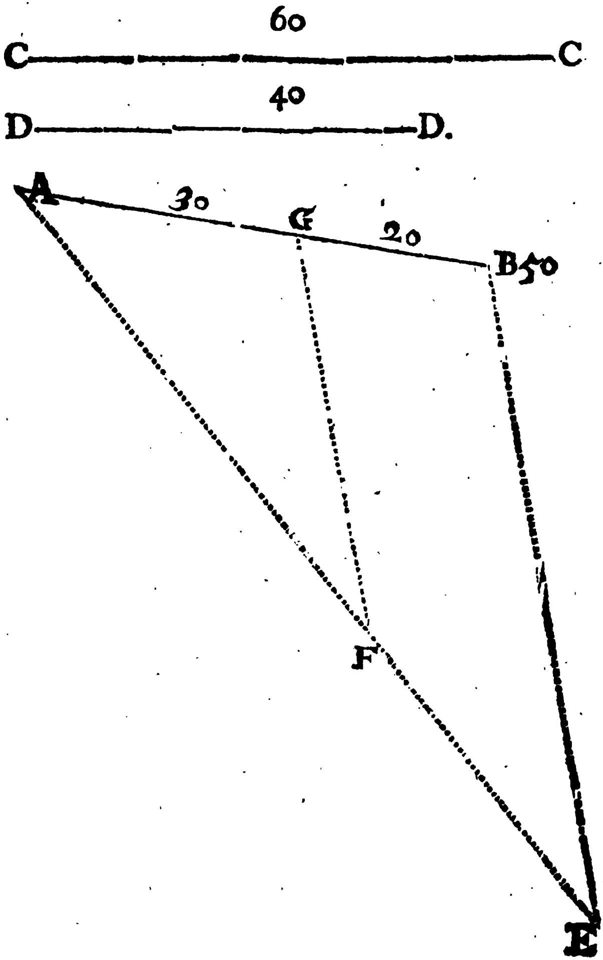
Fig. 3. This needs no Deſcription, it being ſo like the two former Figures, and eaſier than either of them.

Here note, that you make the Ovals 1 and 3 of any determined Length; for in the Length of the firſt, there is four Semidiameters of the ſmall Circles; and in the laſt, but three. If therefore any Line was given you, of which Length an Oval was required, you muſt take in your Compaſſes the fourth Part of the Line to make the Oval *Fig.* 1. and the third Part to make the Oval *Fig.* 3. and with that Extent you muſt deſcribe the ſmall Circles: The Breadth will be always proportional to the Length. But if the Breadth be given you, take in alſo the fourth Part thereof, and make the Oval *Fig.* 2.

Fig. 4. This Ellipſis is to be made, having Length and Breadth both given. Let A B be the Length, C D the Breadth of a required Oval. Firſt, Lay down the Line A B equal to the given Length, and croſs it in the middle with the Perpendicular C D, equal to the given Breadth. Secondly, Take in half the Line A B with your Compaſſes, *viz.* A *e*, or B *e*; ſet one Foot in C, and make two Marks upon the Line A B, *viz.* *f* and *g*; alſo with the ſame Extent ſet one Foot in D, and croſs the former Marks at *f* and *g*. Thirdly, At the Point *f* and *g* fix two Pins; or if it be a Garden-plat, or the like, two ſtrong Sticks. Then putting a Line about them, make faſt the two Ends at ſuch an exact Length, that ſtretching by the two Pins, the Bent of the Line may exactly touch A or B, or C or D, or *h*, as in this Diagram it does at *h*; ſo moving the Line ſtill round, it will deſcribe an exact Oval.

PROB. XVI.

How to divide a given Line into two Parts, which may be in ſuch Proportion to each other as two given Lines.



Let A B be the given Line to be divided in ſuch Proportion as the Line C is to the Line D.

Firſt, From A draw a Line at pleaſure, as A E; then taking with your Compaſſes the Line C, ſet it off from A towards E, which will fall at F: Alſo take the Line D, and ſet off from F to E.

Secondly, Draw the Line E B; and from F make a Line parallel to E B, as F G, which ſhall interſect the given Line A B in the proportional Point required, *viz.* at G; making A G and G B in like Proportion to each other, as C C and D D.

Example by Arithmetick.

The Line C C is 60 Feet, Perches, or any thing elſe; the Line D D is 40; the Line A B is 50; which is required to be divided in ſuch Proportion as 60 to 40. Firſt add the two Lines C and D together, and they make 100: then ſay, If 100 the whole, give 60 for its greateſt Part, what ſhall 50, the whole Line A B, give for its greateſt proportional Part? Multiply 50 by 60, it makes 3000; which divided by 100, produces 30 for the longeſt Part; which 30 taken from 50, leaves 20 for the ſhorteſt Part: as therefore 60 is to 40, ſo is 30 to 20.

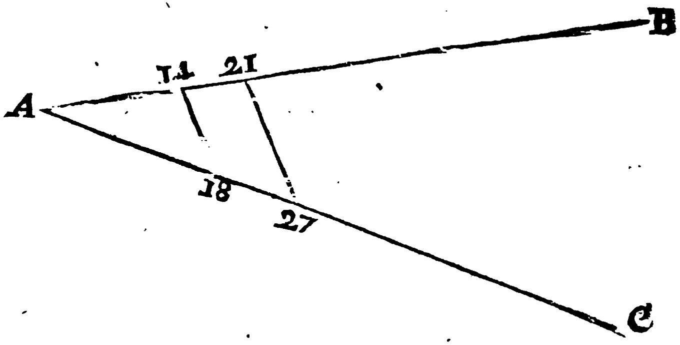
PROB. XVII.

Three Lines being given, to find a Fourth in Proportion to them.

A———14
B————18
C——————21

Let A B C be the three Lines given, and it is required to find a fourth Line, which may be in ſuch Proportion to C, as B is to A, which is no more but performing the *Rule of Three* in Lines. As if we ſhould ſay, If A 14 give B 18, what ſhall C 21 give? Anſwer, 27. But to perform the ſame geometrically, work thus:

Firſt, Make any Angle, as BAC: then take with your Compaſſes the firſt Line A, and ſet it from A to 14. Alſo take the ſecond Line B, and ſet it from A to 18; draw the Line 14, 18. Then take the third Line C with your Compaſſes, and ſet it from A to 21. From 21 draw a Line parallel to 14, 18, which will be 21, 27. Then from A to 27 is the Length of your fourth Line required.



And here for a while I ſhall leave theſe *Problems*, till I come to ſhew you how to divide any Piece of Land; and to lay out any Piece of a given Quantity of Acres into any Form or Figure required: And in the mean time I ſhall ſhew you what is neceſſary to be known.

CHAP.

CHAP. II.

Of MEASURES.

AND firſt of Long Meaſures; which is either Inches, Feet, Yards, Perches, Chains, *&c.* Note, that twelve Inches make one Foot, three Feet one Yard, five Yards and an half one Pole or Perch, four Perches one Chain of *Gunter*'s, eighty Chains one Mile. But if you would bring one Sort of Meaſure into another, you muſt work by *Multiplication* or *Diviſion.* As for Example: Suppoſe you would know how many Inches are contained in twenty Yards: Firſt, Reduce the Yards into Feet by multiplying them by 3, becauſe 3 Feet make one Yard, the Product is 60; which multiplied by 12, the Number of Inches in one Foot, gives 720, and ſo many Inches are contained in 20 Yards Length.

On the contrary, if you would have known how many Yards there are in 720 Inches, you muſt firſt divide 720 by 12, the Quotient is 60 Feet; that again divided by 3, the Quotient is 20 Yards. The like you muſt do with any other Meaſure, as Perches, Chains, *&c.* of which more by and by.

Long	Link	Foot	Yard	Perch	Chain	Mile
Inches	7.92	12	36	198	792	63360
	Link	1.515	4.56	25	100	8000
		Feet	3	16.5	66	5280
			Yard	5.5	22	1760
				Perch	4	320
					Chain	80

See this Table of the Long Meaſure annexed, the Uſe whereof is very eaſy: If you would know how many Feet in Length go to make one Chain; look for Chain at the Top, and at the Left-hand for Feet, againſt which, in the common Angle of meeting, is 66; ſo many Feet are contained in one Chain.

But becauſe Mr. *Gunter*'s Chain is moſt in Uſe among Surveyors for meaſuring of Lines, I ſhall chiefly inſiſt on that Meaſure, it being the beſt in Uſe for Lands.

This Chain contains in Length 4 Pole, or 66 Feet, and is divided into 100 Links, each Link is therefore in Length $7\frac{92}{100}$ Inches: If you would turn any Number of Chains into Feet, you muſt multiply them by 66, as 100 Chains multiplied by 66, makes 6600 Feet; but if you have Links to your Chains to be turned into Feet and Parts of Feet, you muſt ſet down the Chains and Links, as if they were one whole Number, and after having multiplied that Number by 66, cut off from the Product the two laſt Figures to the Right-hand, which will be the hundredth Parts of a Foot, and thoſe on the Left-hand the Feet required.

EXAMPLE.

Let it be required to know how many Feet there are in 15 Chains, 25 Links.

I ſet down thus the *Multiplicand* 1525
The Num. of Feet in 1 Chain, *Multiplicat.* 66

9150
9150

Product 1006|50 Feet.

The *Product* is $1006\frac{50}{100}$. This is ſo plain, it needs no other Example.

But now on the other hand, if one thouſand and ſix Feet and an half was given you to reduce into Chains and Links; you muſt divide 100650 by 66, the Quotient will be 1525, *viz.* 15 Chains, 25 Links. But for thoſe that do not well underſtand *Decimal Arithmetick*, and may perhaps meet with harder Queſtions of this nature, I have inſerted this Table.

A TABLE, ſhewing how many Feet, and Parts of a Foot; alſo how many Perches, and Parts of a Perch, are contained in any Number of Chains and Links, from one Link to one hundred Chains.

Links.	Feet.	Parts of a Foot.	Perches.	Parts of a Perch.	Chains.	Feet.	Perches.
1	00	.66	0	.04	1	66	4
2	01	.32	0	.08	2	132	8
3	01	.98	0	.12	3	198	12
4	02	.64	0	.16	4	264	16
5	03	.30	0	.20	5	330	20
6	03	.96	0	.24	6	396	24
7	04	.62	0	.28	7	462	28
8	05	.28	0	.32	8	528	32
9	05	.94	0	.36	9	594	36
10	06	.60	0	.40	10	660	40
20	13	.20	0	.80	20	1320	80
30	19	.80	1	.20	30	1980	120
40	26	.40	1	.60	40	2640	160
50	33	.00	2	.00	50	3300	200
60	39	.60	2	.40	60	3960	240
70	46	.20	2	.80	70	4620	280
80	52	.80	3	.20	80	5280	320
90	59	.40	3	.60	90	5940	360
100	66	.00	4	.00	100	6600	400

The Explanation of the TABLE.

If you would know how many Feet are contained in twenty of Mr. *Gunter*'s Chains:

Firſt, Under Title *Chains*, ſeek for 20; and right againſt it, under Title *Feet*, ſtands 1320, the Number of Feet contained in twenty Chains. Alſo under Title *Perches* ſtands 80, the Number of Perches contained in twenty Chains.

Again: If you would know how many Feet are contained in eight Links only of the Chain, ſeek 8 under Title *Links*, and right againſt it ſtands 05.28, which is five Feet $\frac{28}{100}$ of a Foot, ſomething more than five Feet and a quarter. Alſo under Title *Perches* and Parts of a Perch, ſtands 0.32; which ſignifies that 8 Links contain 0 Perch $\frac{32}{100}$ of a Perch. But to know how many Feet are contained in any Number of Chains and Links together: Firſt ſeek the Feet anſwering to the whole Chains, and write them down next the firſt anſwering the Links; and adding them to the other, you will have your Deſire. *Example:* In 15 Chains, 25 Links, how many Feet? Firſt, by the Table I find 10 Chains to contain 660 Feet, which I write down thus.

And when you have added them together, you find the Sum to be 1006 Feet, and $\frac{50}{100}$ of a Foot, that is contained in 15 Chains, 25 Links.

	Chains,	*Feet*,	*Parts.*
	10	660	
	5	330	
Links	20	13	20
	5	3	30
Added		1006	50

In like manner, if it had been aſked how many Perches had been contained in 15 Chains, 25 Links?

	Perch.	*Parts.*
In the Table againſt 10 Chains ſtands	40	
5	20	
20 *Links.*	00	80
5 *Links.*	00	20
Anſwer, 16 *Perches.*	60	100

Mark, that the foregoing Table is as big again as it need to be; for you ſee both the Columns are alike in Figures, and only differenced by Points. I made it ſo for your clearer underſtanding of it; which when you well do, you need uſe no more but one Column; and that if you pleaſe, you may have placed on a Scale, or any other Inſtrument. But now to bring a leſſer Meaſure into a greater, is ſo much harder than to bring a greater into a leſs, as *Diviſion* is harder than *Multiplication:* I have therefore, for your Eaſe, hereto annexed a large Table, with which by Inſpection only, or at moſt by a little eaſy Addition, as in the former, you may change any Number of Feet into Chains, Links and Parts of a Link (remembring all this while I mean Mr. *Gunter*'s Chain); alſo into Perches, and Parts of a Perch.

A TABLE, ſhewing how many Chains, Links, and Parts of a Link; alſo how many Perches, and Parts of a Perch, are contained in any Number of Feet from 1 to 10000.

Feet.	Chain	Link	P. of L	Per	P. of Per.
1	0	1	515	0	060
2	0	3	030	0	121
3	0	4	545	0	181
4	0	6	060	0	242
5	0	7	575	0	303
6	0	9	090	0	363
7	0	10	606	0	424
8	0	12	121	0	484
9	0	13	636	0	545
10	0	15	151	0	606
20	0	30	303	1	212
30	0	45	454	1	818
40	0	60	606	2	424
50	0	75	757	3	030
60	0	90	909	3	636
70	1	06	060	4	242
80	1	21	212	4	848
90	1	36	363	5	454
100	1	51	515	6	060
200	3	03	030	12	121
300	4	54	545	18	181
400	6	06	060	24	242
500	7	57	575	30	303
600	9	09	090	36	363
700	10	60	606	42	424
800	12	12	121	48	484
900	13	63	636	54	545
1000	15	15	151	60	606
2000	30	30	303	121	212
3000	45	45	454	181	818
4000	60	60	606	242	424
5000	75	75	757	303	030
6000	90	90	909	363	636
7000	106	06	060	424	242
8000	121	21	212	484	848
9000	136	36	363	545	454
10000	151	51	515	606	060

This Table is like the former, and needs not much Explanation. However, I will give an Example or two.

Admit I would know how many Chains in Length are contained in 500 Feet. Firſt, in the Left-hand Column; under Title *Feet*, I look out 500, and right againſt it I find 7 Chains, 57 Links, 575 Parts of 1000 of a Link, or 7 Chains, $57\frac{575}{1000}$ Links. So likewiſe under Title *Perches*, I find $30\frac{303}{1000}$ Perches. But if you would know how many odd Feet that $\frac{303}{1000}$ is, you muſt ſeek for 303 in the Column titled *Parts of a Perch*, and right againſt it you will find 5 Feet. So I ſay that 500 Feet is 30 Perches, 5 Foot.

Again, I would know how many Chains and Links there are in 15045 Feet; Firſt ſeek for 10000, and write down the Chains, Links, and Parts of a Link contained therein. Do the like by 5000; alſo by 40 and 5. Laſtly, adding them together, you have your Deſire.

Feet.	*Chain.*	*Link.*	*Parts.*
10000 —	151 =	51 =	515
5000 —	75 =	75 =	757
40 —	0 =	60 =	606
5 —	0 =	7 =	575
Added, make —	227	95	453

Anſwer, 227 Chains, 95 Links, and 453 Parts are contained in 15045 Feet.

One *Example* more, and I have done with this Table.

How many Perches do 10573 Feet make?

Feet.

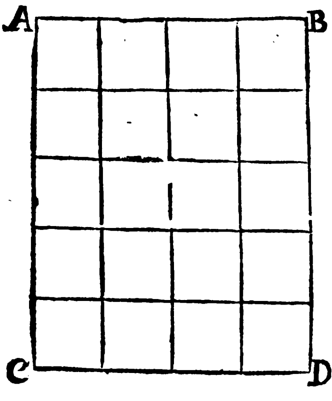
	Feet.	Perches.	Parts.
	10000	606	060
	500	30	303
	70	4	242
	3	0	181
Add		640	786

The Anſwer is, 640 Perches, and $\frac{786}{1000}$ of a Perch, or 13 Feet; a Furlong is 40 Perches in Length; 8 Furlongs make 1 Mile. And ſo much of *Long Meaſure:* I ſhall now proceed to

Square Meaſure.

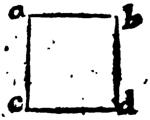
Planometry, or the meaſuring the Superficies or Planes of Things (as Sir *Jonas Moore* ſays) is done with the Squares of ſuch Meaſures, as a Square Foot, a Square Perch, or Chain; that is to ſay, by Squares whoſe Sides are a Foot, a Perch, or Chain; and the Content of any Superficies is ſaid to be found, when we know how many ſuch Squares it containeth.

As for Example: Suppoſe ABCD was a Piece of Land, and the Length of the Line AB or CD was 4 Perches; alſo the Length of the Line AC or BD was 5 Perches; I ſay that Piece of Land contains 20 ſquare Perches, as you may ſee it here divided; every little Square being a Perch, having a Perch in Length for its Side. If you lay down a ſquare Figure, whoſe



whoſe Side is 1 Foot, and at the End of every Inch you draw Lines croſſing one another, as theſe here, you will divide that ſquare Foot into 144 little Squares, or ſquare Inches.

Or thus: The Line *a b* is a Perch long, or 16 Feet ½, ſo is the Line *b d*, and the other 2 Lines: the whole Figure *a b c d* is called a ſquare Perch.



But before we go any farther, take this Table following of Square Meaſure.

A TABLE of SQUARE MEASURE.

	Inch.	Links.	Feet.	Yards.	Pace.	Perch.	Chain	Acre	Mile.
Inch	1								
Links	62.726	1							
Feet	144	2.295	1						
Yards	1296	20.755	9	1					
Pace	3600	57.381	25	2.778	1				
Perch	39204	625	272.25	30.25	10.89	1			
Chain	627264	10000	4356	484	174.24	16	1		
Acre	6272640	100000	43560	4840	1742.4	160	10	1	
Mile	4014489600	6400000	27878400	3097600	1115136	102400	6400	646	1

Mile.

This Table is like the former of long Meaſure, and the Uſe of it is the ſame.

Example: If you would know how many ſquare Feet are contained in one Chain, look for Feet at Top, and Chain on the Side, and in the common Angle of meeting ſtands 4356, ſo many ſquare Feet are contained in one ſquare Chain.

The common Meaſure for Land is the Acre, which by Statute is appointed to contain 160 ſquare Perches, and it matters not in what Form the Acre lie, ſo it contains juſt 160 ſquare Perches; as in a Parallelogram, 10 Perches one way, and 16 another, contain an Acre: So does 8 one way, and 20 another; and 4 one way, and 40 another. If then, having one Side given in Perches, you would know how far you muſt go on the Perpendicular to cut off an Acre; you muſt divide 160 (the Number of ſquare Perches in an Acre) by the given Side, the Quotient is your Deſire. As for Example: The given Side is 20 Perches, divide 160 by 20, the Quotient is 8: By that I know, that 20 Perches one way, and 8 another, including a right Angle, will be the two Sides of an Acre; the other two Sides muſt be parallel to theſe.

And here I think it convenient to inſert this neceſſary Table, ſhewing the Length and Breadth of an Acre in Perches, Feet, and Parts of a Foot: But if your given Side had been in any other Sort of Meaſure; as for Inſtance in Yards, you muſt then have ſeen how many ſquare Yards had been in an Acre, and that Sum you muſt have divided by the Number of your given Yards, the Quotient would have anſwered the Queſtion.

EXAMPLE.

If 44 Yards be given for the Breadth, how many Yards ſhall there be in the Length of the Acre?

First, I find that an Acre contains 5840 ſquare Yards, which I divide by 44, the Quotient is 110 for the Length of an Acre. And thus knowing well how to take the Length and Breadth of an Acre, you may alſo by the ſame way know how to lay down any Number of Acres together; of which more hereafter.

Breadth Perches.	Length of an Acre.		Breadth Perches.	Length of an Acre.	
	Perches.	Feet.		Perches.	Feet.
10	16	0	28	5	$11\frac{3}{4}$
11	14	9	29	5	$8\frac{1}{2}\frac{1}{3}$
12	13	$5\frac{1}{2}$	30	5	$5\frac{1}{2}$
13	12	$5\frac{1}{13}$	31	5	$2\frac{1}{3}$
14	11	$7\frac{1}{12}$	32	5	0
15	10	11	33	4	14
16	10	0	34	4	$11\frac{2}{3}$
17	9	$6\frac{9}{12}$	35	4	$9\frac{5}{21}$
18	8	$14\frac{8}{12}$	36	4	$7\frac{1}{2}$
19	8	$6\frac{1}{12}$	37	4	$5\frac{1}{2}$
20	8	0	38	4	$3\frac{2}{3}$
21	7	$10\frac{1}{2}$	39	4	$1\frac{1}{2}$
22	7	$4\frac{1}{2}$	40	4	0
23	6	$15\frac{3}{4}$	41	3	$14\frac{21}{24}$
24	6	11	42	3	$13\frac{1}{3}$
25	6	$6\frac{7}{12}$	43	3	$11\frac{21}{22}$
26	6	$2\frac{1}{22}$	44	3	$10\frac{1}{3}$
27	5	15	45	3	$2\frac{1}{5}$

Reducing of one Sort of ſquare Meaſure to another, is done, as before taught in long Meaſure, by Multiplication and Diviſion. And becauſe Mr. *Gunter*'s Chain is chiefly uſed by Surveyors, I ſhall only inſtance in that, and ſhew you how to turn any Number of Chains and Links into Acres, Roods, and Perches. Note, that a Rood is the fourth Part of an Acre.

And firſt, mark well that 10 ſquare Chains make 1 Acre, that is to ſay, 1 Chain in Breadth, and 10 in Length; or 2 in Breadth, and 5 in Length, is an Acre, as you may ſee by this ſmall Table.

Chains. Length of an Acre.	Chains. Breadth of an Acre.	Links.	Parts of a Link.
1	10	00	
2	5	00	
3	3	33	333
4	2	50	
5	2	00	
6	1	66	666
7	1	42	285
8	1	25	
9	1	11	111

And thus well weighing that 10 Chains make an Acre, if any Number of Chains be given you to turn into Acres, you muſt divide them by 10, and the Quotient will be the Number of Acres contained in ſo many Chains. But this Diviſion is abbreviated by only cutting off the laſt Figure; as if 1590 Chains were given to turn into Acres, by cutting off the laſt Figure 159|0, there is left 159 Acres, which is all one as if you had divided 1590 by 10. But if Chains and Links be given you together to turn into Acres, Roods and Perches, firſt from the given Sum cut off three Figures, which is two Figures for the Links, and one for the Chains, what's left ſhall be Acres. And to know how many Roods and Perches are contained in the Figures cut off, multiply them by 4; and from the Product, cutting off the three laſt Figures, you will have the Roods: And then to know the Perches, multiply the Figures cut off from the Roods, by 40; from which Product, cutting off again three Figures, you have the Perches, and the Figures cut off are thouſandth Parts of a Perch.

EXAM-

EXAMPLE.

In 1599 ſquare Chains, and 55 ſquare Links, how many Acres, Roods, and Perches?

Acres —— 159|955
4
Answer, 159 Acres, 3 Rood
32 [illegible]
Roods —— 3|620
40
Perches —— 24|800

On the contrary, if to any Number of Acres given you add a Cypher, they will be turned into Chains: Thus 99 Acres are 990 Chains, 100 Acres 1000 Chains, *&c.* the ſame as if you had multiplied the Acres by 10. And if you would turn ſquare Chains into ſquare Links, add four Cyphers to the End of the Chains, ſo will 990 Chains be 9900000 Links, 1000 Chains be 10000000 Links; all one as if you had multiplied 990 by 10000, the Number of ſquare Links contained in one Chain.

And now, whereas in caſting up the Content of a Piece of Land meaſured by Mr. *Gunter*'s Chain, (*viz.* multiplying Chains and Links by Chains and Links) the Product will be ſquare Links; you muſt therefore from that Product cut off five Figures to find the Acres; which is the ſame as if you divide the Product by 100000 (the Number of ſquare Links contained in one Acre) then multiply the five Figures cut off by 4; and from that Product cutting off five Figures you will have the Roods.

Laſtly, multiply by 40, and take away (as before) 5 Figures, the reſt are Perches.

EXAMPLE.

Admit a Parallelogram, or long Square, to be one way 5 Chains, 55 Links; and the other way 4 Chains, 35 Links: I demand the Content in Acres, Roods and Perches?

	Multiplicand	555
	Multiplicator	435
		2775
		1665
		2220
Anſwer, 2 *Acres*	*Acres*	2|41425
		4
1 *Rood*		
	Roods	1|65700
26 *Perches*		40
And $\frac{28}{100}$ *Parts* of a *Perch.*		
	Perches	26|28000

Laſtly, Becauſe ſome Men chuſe rather to caſt up the Content of Land in Perches, I will here briefly ſhew you how it is done; which is only by dividing by 160 (the Number of ſquare Perches contained in one Acre) the Number of Perches given.

EXAMPLE.

Admit a Parallelogram to be in length 55 Perches, and in breadth 45 Perches; theſe two multiplied together, make 2475 Perches; which to turn into Acres, divide by 160, the Quotient is 15 Acres, and 75 Perches remaining; which to turn into Roods, divide by 40, the Quotient is 1 Rood, and 35 Perches remaining. So much is the Content of ſuch a Piece of Land, *viz.* 15 Acres, 1 Rood, and 35 Perches.

Here follows a Table to turn Perches into Acres, Roods and Perches.

Perches.	Acres.	Roods.	Perches.
40	0	1	00
50	0	1	10
60	0	1	20
70	0	1	30
80	0	2	00
90	0	2	10
100	0	2	20
200	1	1	00
300	1	3	20
400	2	2	00
500	3	0	20
600	3	3	00
700	4	1	20
800	5	0	00
900	5	2	20
1000	6	1	00
2000	12	2	00
3000	18	3	00
4000	25	0	00
5000	31	1	00
6000	37	2	00
7000	43	3	00
8000	50	0	00
9000	56	1	00
10000	62	2	00
20000	125	0	00
30000	187	2	00
40000	250	0	00
50000	312	2	00
60000	375	0	00
70000	437	2	00
80000	500	0	00
90000	562	2	00
100000	625	0	00

The Uſe of the TABLE.

In 2475 Perches, how many Acres, Roods and Perches.

	Perch.	Acr.	Rood.	Per.
	2000	12	2	00
	400	2	2	00
	70	0	1	30
To which add the odd 5 Perches		0	0	05
	Anſwer	15	1	35

CHAP. V.

Of Inſtruments and their Uſes.

And firſt of the Chain.

THERE are ſeveral Sorts of Chains, as Mr. *Rathborne*'s of two Perch long; others of one Perch long: ſome have had them 100 Feet in Length. But that which is moſt in Uſe among Surveyors (as being indeed the beſt) is Mr. *Gunter*'s, which is 4 Pole long, containing 100 Links, each Link being $7\frac{92}{100}$ Inches: The Deſcription of which Chain, and how to reduce it into any other Meaſure, you have at large in the foregoing Chapter of Meaſure. In this place I ſhall only give you ſome few Directions for the Uſe of it in meaſuring Lines.

Take care that they who carry the Chain deviate not from a ſtrait Line; which you may do by ſtanding at your Inſtrument, and looking thro' the Sights: If you ſee them between you and the Mark obſerved, they are in a ſtrait Line, otherwiſe not. But without all this trouble, they may carry the Chain true enough, if he that follows the Chain always cauſes him that goeth before to be in a direct Line between himſelf, and the Place they are going to, ſo as that the Foreman may always cover the Mark from him that goes behind. If they ſwerve from the Line, they will make it longer than really it is, a ſtrait Line being the neareſt Diſtance that can be between any two Places.

Be ſure that they which carry the Chain, miſtake not a Chain either over or under in their Account; for if they ſhould, the Error would be very conſiderable; as ſuppoſe you were to meaſure a Field that you knew to be exactly ſquare, and therefore need meaſure but one Side of it; if the Chain-carriers ſhould miſtake but one Chain, and tell you the Side was but 9 Chains when it was really 10, you would make of the Field but 8 Acres and 16 Perches, when it ſhould be 10 Acres juſt. And if in ſo ſmall a Line ſuch a great Error may ariſe, what may be in a greater, you may eaſily imagine; but the uſual way to prevent ſuch Miſtakes, is to be provided with 10 ſmall Sticks, ſharp at one End, to ſtick in the Ground; and let him that goes before take all into his Hand at ſetting out, and at the End of every Chain ſtick down one, which let him that follows take up; when the 10 Sticks are done, be ſure they have gone 10 Chains; then if the Line be longer, let them change the Sticks, and proceed as before, keeping in memory how often they change: They may either change at the End of 10 Chains, then the hindmoſt Man muſt give the foremoſt all his Sticks; or, which is better, at the End of 11 Chains, and then the laſt Man muſt give the firſt but 9 Sticks, keeping one to himſelf. At every Change count the Sticks, for fear leſt you have dropt one, which ſometimes happens.

If you find the Chain too long for your Uſe, as for ſome Lands it is, eſpecially in *America*, you may then take the half of the Chain, and meaſure as before, remembring ſtill when you put down the

Lines in your Field-Book; that you ſet down but the Half of the Chains, and the odd Lines; as if a Line meaſured by the little Chain be 11 Chains, 25 Links, you muſt ſet down 5 Chains, 75 Links; and then in plotting and caſting up, it will be the ſame as if you had meaſured by the whole Chain.

At the End of every 10 Links you may, if you find it convenient, have a Ring, a Piece of Braſs or a Rag, for your more ready reckoning the odd Links.

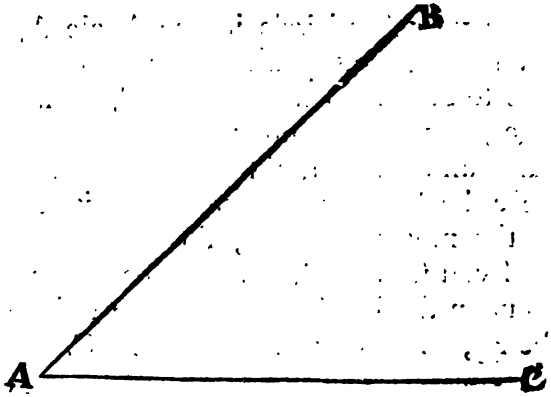
When you put down in your Field-Book the Length of any Line, you may ſet it thus, if you pleaſe, with a Stop between the Chains and Links, as 15 Chains, 15 Links, 15.15; or without, as thus, 1515, it will be all one in the caſting up.

Of Inſtruments for the taking of an Angle in the Field.

There are but two material Things (towards the meaſuring of a Piece of Land) to be done in the Field; the one is to meaſure the Lines (which I have ſhewed you how to do by the Chain) and the other to take the Quantity of an Angle included by theſe Lines; for which there are almoſt as many Inſtruments as there are Surveyors. Such among the reſt as have got the greateſt Eſteem in the World, are the plain Table for ſmall Incloſures, the Semicircle for champaign Grounds, the Circumferentor, the Theodolite, *&c.* To deſcribe theſe to you, their Parts, how to put them together, take them aſunder, *&c.* is like teaching the Art of Fencing by Book; one Hour's Uſe of them, or but looking on them in the Inſtrument-maker's Shop, will better deſcribe them to you, than the reading one hundred Sheets of Paper concerning them. Let it ſuffice that the only Uſe of them all is no more (or chiefly at moſt) but this, *viz.*

To take the Quantity of an Angle.

As ſuppoſe AB and AC are two Hedges, or other Fences of a Field, the Chain ſerves to meaſure the Length of the Sides A B or A C, and theſe Inſtruments we are ſpeaking of, are to take the Angle A. And firſt by the



Plain Table.

Place the Table (already fitted for the Work, with a Sheet of Paper upon it) as nigh to the Angle A as you can, the North-end of the Needle hanging directly over the *Flower-de-luce*; then make a Mark upon the Sheet of Paper at any convenient Place for the Angle A, and lay the Edge of the Index to the Mark, turning it about, till through the Sights you eſpy B, then draw the Line A B by the Edge of the Index. Do the ſame for the Line A C, keeping the Index ſtill upon the firſt Mark, then will you have upon your Table an Angle equal to the Angle in the Field.

To take the Quantity of the ſame Angle by the Semicircle.

Place your Semicircle in the Angle A, as near the very Angle as poſſibly you can, and cauſe Marks to be ſet up near B and C, ſo far off the Hedges, as your Inſtrument at A ſtands; then turn the Inſtrument about, till through the fixed Sights you ſee the Mark at B, there ſcrew it faſt: Next turn the moveable Index, till through the Sights thereof you ſee the Mark at C, then ſee what Degrees upon the Limb are cut by the Index; which let be 45, ſo much is the Angle A B C.

How to take the ſame Angle by the Circumferentor.

Place your Inſtrument, as before, at A, with the *Flower-de-luce* towards you, direct your Sights to the Mark at B, and ſee what Degrees are then cut by the South-end of the Needle, which let be 55; do the ſame to the Mark at C, and let the South-end of the Needle there cut 100; ſubtract the leſſer out of the greater, the Remainder is 45, the Angle required. If the Remainder had been more than 180 Degrees, you muſt then have ſubtracted it out of 360, the laſt Remainder would have been the Angle deſired.

This laſt Inſtrument depends wholly upon the Needle for taking of Angles, which often proves erroneous; the Needle yearly of itſelf varying from the true *North*, if there be no Iron Mines in the Earth, or other Accidents to draw it aſide, which in mountainous Lands are often found: It is therefore the beſt Way for the Surveyor, where he poſſibly can, to take his Angles without the Help of the Needle, as is before ſhewed by the Semicircle. But in all Lands it cannot be done, but we muſt ſometimes make uſe of the Needle, without exceeding great trouble, as in the thick Woods of *Jamaica*, *Carolina*, *&c.* It is good therefore to have ſuch an Inſtrument, with which an Angle in the Field may be taken either with or without the Needle, as is the Semicircle, than which I know no better Inſtrument for the Surveyor's Uſe yet made publick; therefore, as I have before ſhewed you, how by the Semicircle to take an Angle without the Help of the Needle, I ſhall here direct you,

How with the Semicircle to take the Quantity of an Angle in the Field by the Needle.

Screw faſt the Inſtrument, the North-end of the Needle hanging directly over the *Flower-de-luce* in the Chard; turn the Index about, till through the Sights you eſpy the Mark at B; and note what Degrees the Index cuts, which let be 40; move again the Index to the Mark at C, and note the Degrees cut, *viz.* 85. Subtract the leſs from the greater, remains 45, the Quantity of the Angle.

Or thus:

Turn the whole Inſtrument, till thro' the fixed Sights you eſpy the Mark at B, then ſee what Degrees upon the Chard are cut by the Needle; which, for Example, are 315: Turn alſo the Inſtrument till through the ſame Sights you eſpy C, and note the Degrees upon the Chard then cut by the Needle, which let be 270; ſubtract the leſs from the greater, (as before in working by the Circumferentor) remains 45 for the Angle. Mark, if you turn the *Flower-de-luce* towards the Mark, you muſt look at the North-end of the Needle for your Degrees.

Beſides the Diviſion of the Chard of the Semicircle into 360 equal Parts or Degrees; it is alſo divided into four Quadrants, each containing 90 Degrees, beginning at the North and South Point, and proceeding both ways till they end in 90 Degrees at the Eaſt and Weſt Points; which Points are marked contrary, *viz.* Eaſt with a W. and Weſt with an E. becauſe when you turn your Inſtrument to the Eaſtward, the End of the Needle will hang upon the Weſt-ſide, &c.

If by this way of Diviſion of the Chard you would take the aforeſaid Angle, direct the Inſtrument ſo (the *Flower-de-luce* from you) till through the fixed Sights you eſpy the Mark at B; then ſee what Degrees are cut by the North-end of the Needle, which let be N E 44; next direct the Inſtrument to C, and the North-end of the Needle will cut N E 89, ſubtract the one from the other, and there will remain 45 for the Angle.

But if at the firſt Sight the Needle had hung over N E 55, and at the ſecond S E 80, then take 55 from 90, remains 35; take 80 from 90, remains 10; which added to 35, makes 45, the Quantity of the Angle: Moreover, if at the firſt Sight the North-end of the Needle had pointed to N W 22, and at the ſecond N E 23, theſe two muſt have been added together, and they would have made 45, the Angle as before.

Mark, If you had turned the South-part of your Inſtrument to the Marks, then you muſt have had reſpect to the South-end of your Needle.

Altho' I have been ſo long ſhewing you how to take an Angle by the Needle, yet when we come to ſurvey Land by the Needle, as you ſhall ſee by and by, we need take but half the pains; for we take not the Quantity of the Angle included by two Lines, but the Quantity of the Angle each Line makes with the Meridian; then drawing Meridian-Lines upon Paper, which repreſent the Needle of the Inſtrument, by the help of a Protractor, which repreſents the Inſtrument, we readily lay down the Lines and Angles in ſuch Proportions as there are in the Field.

This Way of dividing the Chard into four 90s, is, in my Opinion, for any Work the beſt; but there is a greater Uſe yet to be made of it, which ſhall hereafter be ſhewed in its proper place.

Of the Field-Book.

You muſt always have in readineſs in the Field a little Book, in which fairly to inſert your Angles and Lines; which Book you may divide by Lines into Columns, as you ſhall think convenient in your Practice; leaving always a large Column to the Right-hand, to put down what remarkable things you meet with in your way, as Ponds, Brooks, Mills, Trees, or the like. Thus, for Example, if you had taken the Angle A, and found it to contain 45 Degrees; and meaſured the Line A B, and found it to be 12 Chains, 55 Links, ſet it down in your Field-Book thus:

	Degr.	Min.	Chain.	Link.	
A	45	00	12	55	

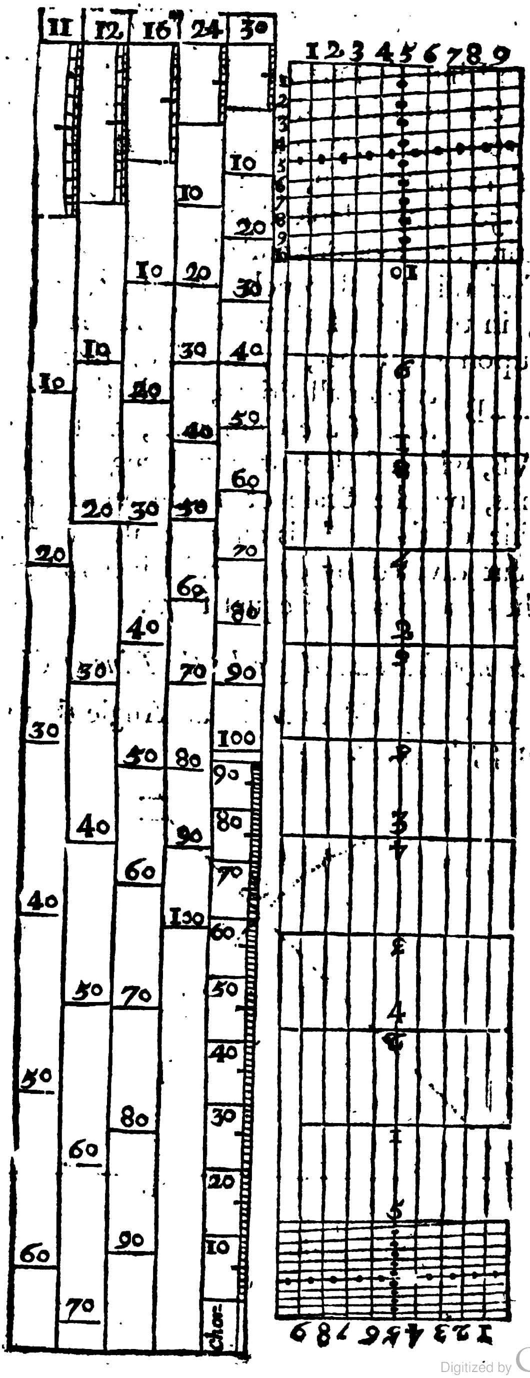
Or if at A you had only turned your fixed Sights to B, and the Needle had then cut 315; in the place of 45, you muſt have put down 315. If you ſurvey by Mr. *Norwood*'s Way, then there muſt be four Columns more for E. W. N. and Southing. You may alſo make two Columns more, if you pleaſe, for Off-ſets, to the right and left.

Laſtly, You may chuſe whether you will have any Lines or not, if you can write ſtrait, and in good Order, the Figures directly one under another. For this I leave you chiefly to your own Fancy; for I believe there are not two Surveyors in *England*, that have exactly the ſame Method for their Field Notes.

Of the Scale.

Having by the Inſtrument before ſpoken of, meaſured the Angles and Lines in the Field; the next Thing to be done, is to lay down the ſame upon Paper; for which Uſe the Scale ſerves. There are ſeveral Sorts of Scales, ſome large, ſome ſmall, according as Men have occaſion to uſe them: but all do principally conſiſt of no more but two Sorts of Lines; the firſt of equal Parts, for the laying down Chains and Links; the ſecond of Chords, for laying down or meaſuring Angles. I cannot better explain the Scale to you, than by ſhewing the Figure of ſuch a one as are commonly ſold in Shops, and teaching how to uſe it.

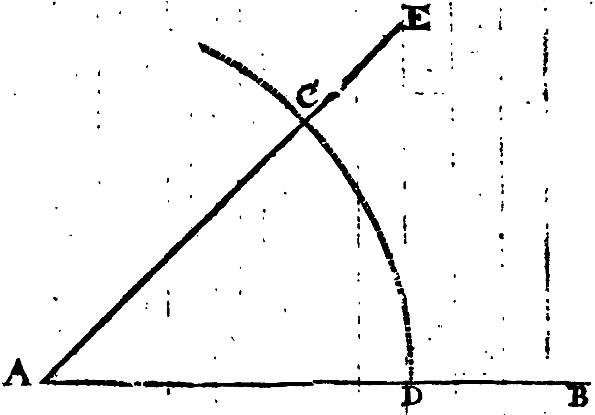
Thoſe


Chor.
1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9

Thoſe Lines that are number'd at top with 11, 12, 16, *&c.* are Lines of equal Parts, containing 11, 12, or 16 equal Parts in an Inch. If now by the Line of 11 in an Inch, you would lay down 10 Chains 50 Links, look down the Line under 11, and ſetting one foot of your Compaſſes in 10, cloſe the other till it juſt touch 50 Links, or half a Chain, in the ſmall Diviſions. Then laying your Ruler upon the Paper, by the Side thereof make two ſmall Pricks, with the ſame Extent of the Compaſſes, and draw the Line AB, which ſhall contain in Length 10 Chains, 50 Links, by the Scale of 11 in an Inch. The Back-ſide of the Scale is only a Scale of 10 in an Inch, but divided by Diagonal Lines more nicely than the other Scales of equal Parts.

How to lay down an Angle by the Line of Chords.

If it were requir'd to make an Angle that ſhou'd contain 45 Degrees.



Draw a Line at pleaſure, as A B; then ſetting one Foot of your Compaſſes at the Beginning of the Line of Chords, ſee that the other fall juſt upon 60 Degrees: With that Extent ſet one Foot in A, and deſcribe the Arch C D. Then take from your Line of Chords 45 Degrees, and ſetting one Foot in D, make a Mark upon the Arch at C, through which draw the Line A E: So ſhall the Angle E A B be 45 Degrees. If by the Line of Chords you would erect a perpendicular Line, it is no more but to make an Angle that ſhall contain 90 Degrees.

The Reaſon why I bid you take 60 from the Line of Chords to make your Arch by, is, becauſe 60 is the Semidiameter of a Circle, whoſe Circumference is 360.

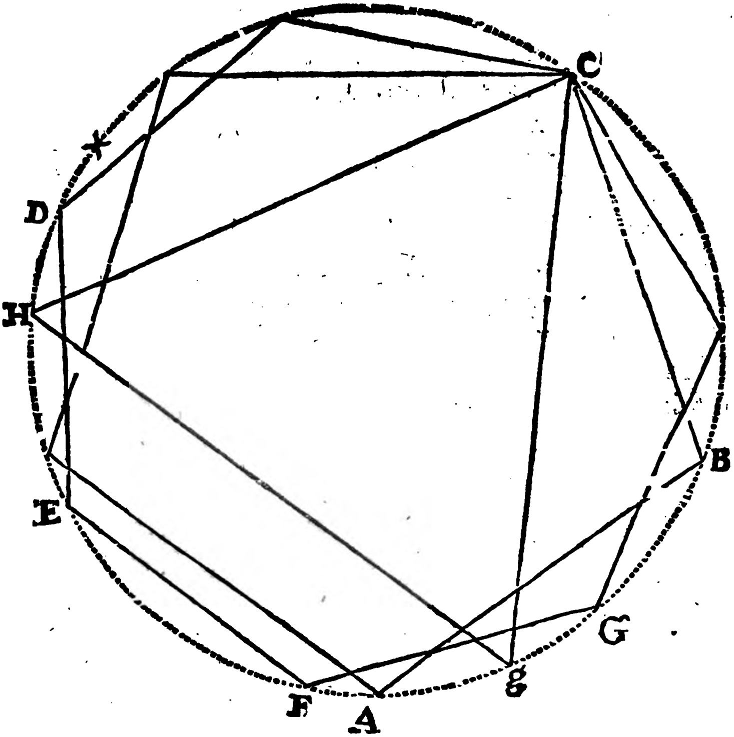
How to make a Regular Polygon, or a Figure of 5, 6, 7, 8, *or more Sides by the Line of Chords.*

Divide 360, the Number of Degrees contained in a Circle, by 5, 6, or 7, the Number of Sides you would have your Figure to contain; the Quotient taken from the Line of Chords ſhall be one Side of ſuch a Figure.

EXAMPLE.

For to make a Pentagon, or a Figure of five Sides: Divide 360 by 5, the Quotient is 72, one Side of a Pentagon.

Take 60 Degrees from your Line of Chords, and deſcribe an obſcure Circle; which done, take 72 from your Line of Chords, and beginning at any Part of the Circle, ſet off that Extent round the Circle, as from A to B, from B to C, and ſo



round till you come to A again. Then having drawn Lines between thoſe Marks, the Pentagon is compleated. The like of any other Polygon, though it contain never ſo many Sides.

As for Example in a Heptagon: Divide 360 by 7, the Quotient will be 51 Degr. 25 Min. which if you take from the Line of Chords, and ſet off round the Circle, you will make a Heptagon, as D E, E F, F G, *&c.* are the Sides thereof.

To

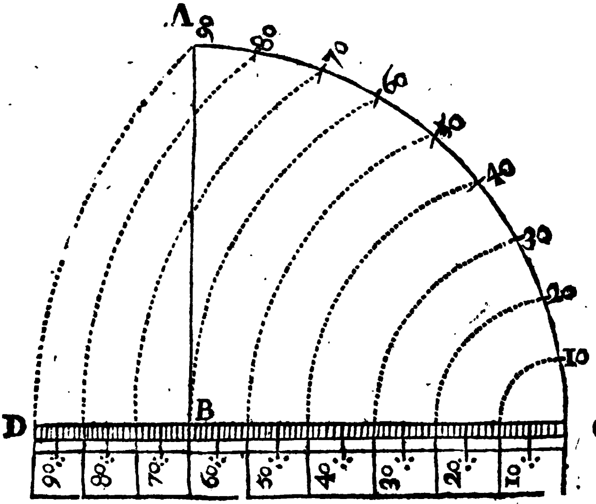
To make a Triangle in a Circle by the Line of Chords.

Firſt, Take the whole Length of your Line of Chords, or the Chord of 90 Degrees, with your Compaſſes; which Diſtance upon the Circle ſet off from C to *. Then take 30 Degrees from the Line of Chords, and ſet that from * to H. Draw the Line C H, which is one Side of the greateſt Triangle that can be made in that Circle.

Or you may make it by ſetting off twice the Semidiameter of the Circle; for 60 and 60 is 120, as well as 90 and 30.

How to make a Line of Chords.

Firſt, Make a Quadrant, or the fourth Part of a



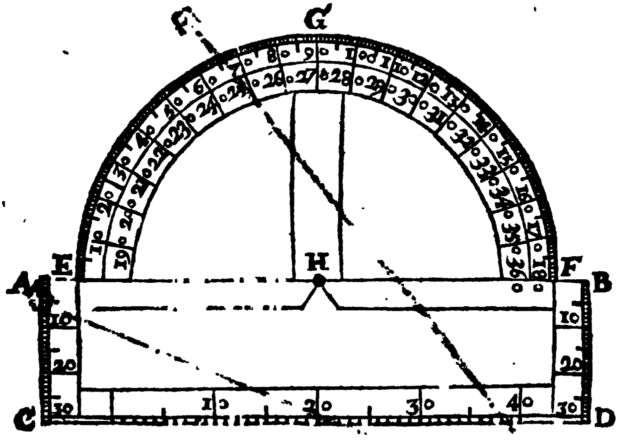
Circle

Circle, as A, B, C; divide the Arch thereof, *viz.* A, C, into 90 equal Parts; which you may do by dividing it firſt into three equal Parts, and every of thoſe Diviſions into three equal Parts more, and every of the laſt Diviſions into ten equal Parts.

Secondly, Continue the Semidiameter B C to any convenient Length, as to D. Then ſetting one Foot of your Compaſſes in C, let the other fall on 90, and deſcribe the Arch 90, 90. So likewiſe 80, 80; 70, 70; and the reſt, C D is the Line of Chords, and theſe Arches cutting it into unequal Parts, conſtitute the true Diviſions thereof, as you may ſee by the Figure: You may, if you pleaſe, draw Lines parallel to D C, as I have done here, for the better diſtinguiſhing every tenth and fifth Figure.

Of the Protractor.

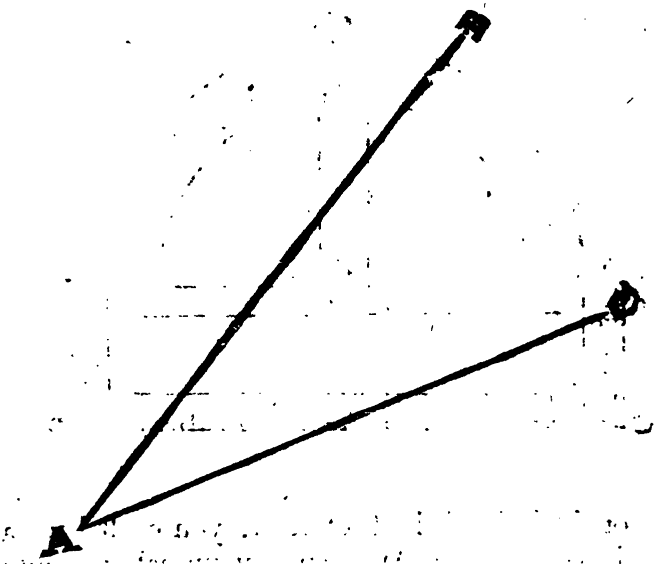
The Protractor is an Inſtrument with which, with more Eaſe and Expedition you may lay down an Angle, than you can by the Line of Chords: Alſo when you have ſurveyed by the Needle, by placing the Diameter of the Protractor upon a Meridian Line made upon your Paper, you readily, with a Needle upon the Arch of the Protractor, prick off the true Situation of any Line from the Meridian without ſcratching the Paper, as you muſt do in the Uſe of the Line of Chords. It is made almoſt like, and graduated together like the Braſs Limb of a Semicircle, performing the ſame upon Paper, as your Inſtrument did in the Field: See here the Figure of it.



For the Uſe of the Protractor, you muſt have a fine Needle, ſuch as Women ſew withal, put into a ſmall Handle of Wood, or Ivory, or the like, which is to put through the Centre of the Protract, or to any Point aſſigned upon the Paper, that the Protractor may turn round upon it.

How to lay down an Angle with the Protractor.

If it were required by the Protractor to lay down an Angle of 30 Degrees, draw the Line A B, then take the Protractor, and putting a Needle through the Centre Point thereof, place the Needle in A, ſo that the Centre of the Protractor may lie juſt upon the End of the Line at A, move the Protractor about till you find the Diameter thereof lie upon the Line A B; then at 30 Degrees upon the Arch,



with your Protracting Needle make a Mark upon the Paper as at C; draw the Line CA, which ſhall make an Angle of 30 Degrees, *viz.* B A C.

If you ſurvey according to Mr. *Norwood*'s Way before ſpoken of, it will be good to have the Arch of your Protractor divided accordingly, *viz.* into two Quadrants, or twice 90 Degrees.

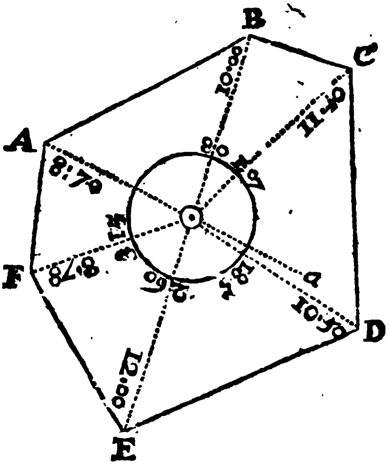
I need ſay no more of a Protractor, any ingenious Man may eaſily find the ſeveral Uſes thereof; it being, as it were, but only an Epitome of Inſtruments.

CHAP.

CHAP. VI.

How to take the Plot of a Field at one Station in any Place thereof, from whence you may ſee all the Angles by the Semicircle.

ADmit ABCDEF to be a Field, of which you are to take the Plot: Firſt ſet your Semicircle upon the Staff in any convenient Place thereof, as at ⊙, and cauſe Marks to be ſet up in every Angle: Direct your Inſtrument, the *Flower-de-luce* from you to any one Angle: as for Example to A; and eſpying the Mark at A through the fixed Sights, there ſcrew faſt the Inſtrument; then



turn the moveable Index about, (the Semicircle remaining immoveable) till through the Sights thereof you eſpy the Mark at B. See what Degrees on the Braſs Limb are cut by the Index, which let be 80; write that down in your Field-Book; ſo turn the Index round to every one of the other Angles, putting down in your Field-Book what Degrees the Index points to. As for Example, at C 107 Degrees, at D 185: *Mark* that at D, the End of the Index will go off the Braſs Limb, and the other End will come on; you muſt therefore look for what Degree the Index cuts in the innermoſt Circle of the Limb at E 260, at F 315 Degrees.

All which you may note down in your Field-Book thus:

Angles.	Degrees.	Minutes.	Chains.	Links.
⊙ A	00 .	00 .	8 .	70
⊙ B	080 .	00 .	10 .	90
⊙ C	107 .	00 .	11 .	40
⊙ D	185 .	00 .	10 .	50
⊙ E	260 .	00 .	12 .	00
⊙ F	315 .	00 .	8 .	78

Secondly, Cauſe the Diſtance between your Inſtrument and every Angle to be meaſured: Thus, from ⊙ to A will be found to be 8 Chains 70 Links; from ⊙ to B, 10 Chains 90. All which ſet down in Order in your Field-Book, as you ſee here above; and then have you done what is neceſſary to be done in that Field towards meaſuring of it. Your next Work is to protract or lay it down upon Paper.

How

How to protract the former Obſervations taken.

Firſt draw a Line at adventure, A *a*; then take from your Scale with your Compaſſes, the firſt Diſtance meaſured, *viz.* from ⊙ to A, 8 Chains, 70 Links; and ſetting one Foot in any convenient Place of the Line, which may repreſent the Place where the Inſtrument ſtood, with the other make a Mark upon the Line as at A, ſo ſhall A be the firſt Angle, and ⊙ the Place where the Inſtrument ſtood.

Secondly, Take a Protractor, and having laid the Center hereof exactly upon ⊙, and the Diameter or Meridian upon the Line A *a*, the Semicircle of the Protractor lying upwards. There hold it faſt, and with your protracting Pen make a Mark upon the Paper againſt 80 deg. 107 deg. *&c.* as you find them in the Field-Book. Then for thoſe Degrees that exceed 180, you muſt turn the Protractor downward, keeping ſtill the Centre upon ⊙, and placing again the Diameter upon *a* A. Mark out by the innermoſt Circle of Diviſions the reſt of your Obſervations 185, 260, 315. Then applying a Scale to ⊙, and every one of the Marks, draw the prick'd Lines ⊙ B, ⊙ C, ⊙ D, ⊙ E, ⊙ F.

Thirdly, Take with your Compaſſes the Length of the Line ⊙ B, which you find by the Field-Book to be 10 Chains, which from ⊙ ſet off to B. The like do for ⊙ C, ⊙ D, and the reſt.

Laſtly, Draw the Lines A B, B C, C D, *&c.* which will incloſe a Figure exactly proportionable to the Field before ſurveyed.

How

How to take the Plot of the ſame Field at one Station by the Plain Table.

Place your Table with a Sheet of Paper upon it at ⊙, and making a Mark upon the Paper that ſhall ſignify where the Inſtrument ſtands, lay your Index to the Mark, turning it about till you ſee through the Sights the Mark at A; there holding it faſt, draw the Line A ⊙. Turn the Index to B, keeping ſtill upon the firſt Mark at ⊙; and when you ſee through the Sights the Mark at B, draw the Line B ⊙. Do the ſame by all the reſt of the Angles, and having meaſured the Diſtance between the Inſtrument and each Angle, ſet it off with your Scale and Compaſſes from ⊙ to A, from ⊙ to B, *&c.* making Marks where, upon the ſeveral Lines, the Diſtances fall.

Laſtly, Between thoſe Marks draw Lines, as AB, BC, CD, *&c.* and then have you the true Plot of the Field ready protracted to your Hand. This Inſtrument is ſo plain and eaſy to be underſtood, I ſhall give no more Examples of the Uſe of it. The greateſt Inconveniency that attends it is, that when never ſo little Rain or Dew falls, the Paper will be wet, and the Inſtrument uſeleſs.

How to take the Plot of the ſame Field at one Station by the Semicircle, either with the Help of the Needle and Limb both together, or by the Help of the Needle only.

In the Beginning of this Chapter, I ſhewed you how to take the Plot of a Field at one Station, by the Semicircle, without reſpect to the Needle, which is the beſt way: But that I may not leave you ignorant of any thing belonging to your Inſtrument, I ſhall here ſhew how to perform the ſame with the Help of the Needle two Ways; and firſt with the Needle and Limb together.

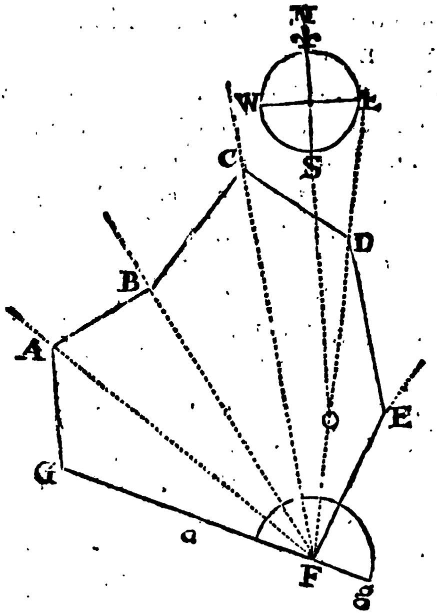
Fix the Inſtrument as before, in ⊙, making the North Point of the Needle hang directly over the *Flower-de-luce* of the Card; there ſcrew faſt the Inſtrument. Then turn the Index to all the Angles, noting down what Degrees are cut thereby at every Angle, as at A let be 25; at B 105, at C 132; and ſo of the reſt round the Field. And when you have meaſured the Diſtances, and are come to Protraction, you muſt firſt draw a Line croſs your Paper, calling it a North and South Line, which repreſents the Meridian Line of the Inſtrument. Then applying the Protractor to that Line, mark round the Degrees as they were obſerved, *viz.* 25, 105, 132, *&c.* and having ſet off the Diſtances, and drawn the outward Lines all together, like what you were taught at the Beginning of the Chapter, you will find the Figure to be the ſame as there.

Now to perform this by the Needle only, is in a manner the ſame as the former: For inſtead of turning the *Index* about the Limb, and ſeeing what Degrees are cut thereby, here you muſt turn the whole Inſtrument about, and obſerve at every Angle what Degrees upon the Card the Needle hangs over; which ſet down and protract as before. But here mind, ſome Cards are number'd from the North Eaſtwards 10, 20, 30, *&c.* to 360 deg. Some from the North Weſtward, which are beſt for this Uſe, Protractors being made accordingly: For when you turn your Inſtrument to the Eaſtward, the Needle will hang over the Weſtward Diviſion, on the contrary.

As for the Uſe of the Diviſion of the Card into four Quadrants, I ſhall ſpeak largely of by and by; therefore for the preſent beg your Patience.

How by the Semicircle to take the Plot of a Field, at one Station, in any Angle thereof, from whence the other Angles may be ſeen.

Let ABCDEFG be the Field; and F the Angle



at which you would take your Obſervations. Having placed your Semicircle at F, turn it about the

North Point of the Card from you, till through the fixed Sights, (*Note*, that I call them the fixed Sights which are on the fixed Diameter) you eſpy the Mark at G. Then ſcrew faſt the Inſtrument; which done, move the Index, till through the Sights thereof you ſee the Mark at A, and the Degrees on the Limb there cut by it will be 20. Move again the Index to the Mark at B, where you will find it to cut 40 deg. Do the ſame at C, and it cuts 60 deg. Likewiſe at D 77, and at E 100 *deg.* Note down all theſe Angles in your Field-Book: Next meaſure all the Lines, as from F to G 14 Chains, 60 Links; from F to A 18 Chains, 20 Links; from F to B 16 Chains, 80 Links; from F to C 21 Chains, 20 Links; from F to D 16 Chains, 95 Links; from F to E 8 Chains, 50 Links; and then will your Field-Book ſtand thus:

Angles.	Degrees.	Minutes.	Chains.	Links.
G	00	00	14	60
A	20	00	18	20
B	40	00	16	80
C	60	00	21	20
D	77	00	16	95
E	110	00	8	50

To protract the former Obſervations.

Draw a Line at adventure, as G*g*, upon any convenient Place; on which lay the Centre of your Protractor, as at F, keeping the Diameter thereof right upon the Line G*g*. Then make Marks round the Protractor at every Angle, as you find them in the Field-Book, *viz.* againſt 20, 40, 60, 77, and 100;

which done, take away the Protractor, and applying the Scale or Ruler to F, and each of the Marks, draw the Lines F A, F B, F C, F D, and F E. Then ſetting off upon theſe Lines the true Diſtances as you find them in the Field-Book; as for the firſt Line F G, 14 Chains, 60 Links; from the ſecond F A, 18 Chains, 20 Links, *&c.* make Marks where the End of theſe Diſtances fall, which let be at G, A, B, C, *&c.*

Laſtly, Between theſe Marks, drawing the Lines G A, A B, B C, C D, D E, E F, F G, you will have compleated the Work.

When you ſurvey thus without the Help of the Needle, you muſt remember before you come out of the Field to make the Meridian Line, that you may be able to make a Compaſs ſhewing the true Situation of the Land, in reſpect of the four Quarters of the Heavens; I mean *Eaſt*, *Weſt*, *North* and *South*: Which thus you may do:

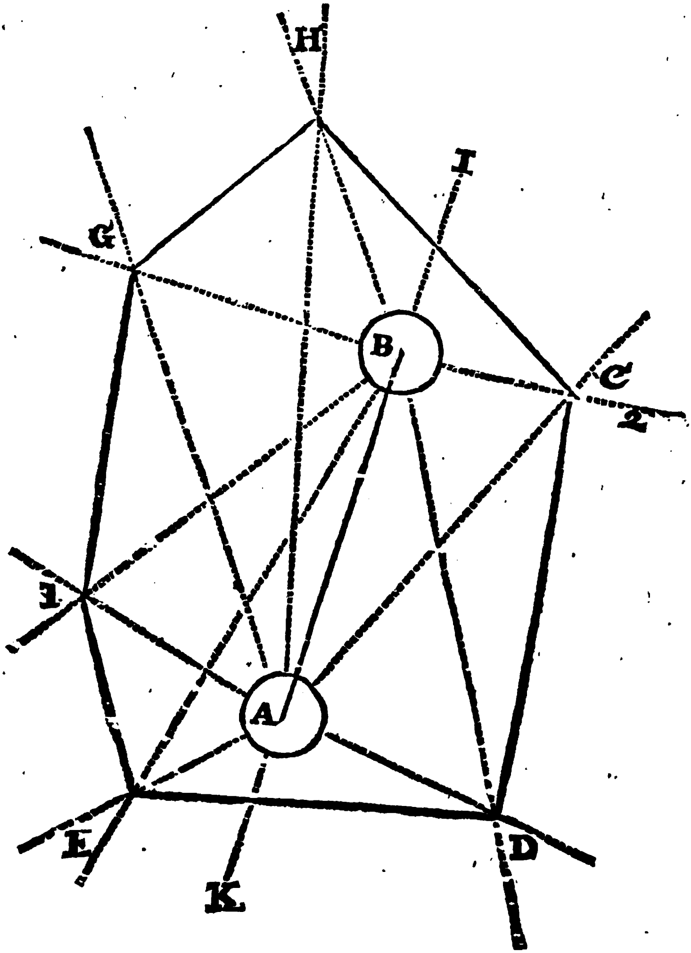
The Inſtrument ſtill ſtanding at F; turn it about till the Needle lies directly over the *Flower-de-luce* of the Card; there ſcrew it faſt. Then turn the moveable *Index*, till through the Sights you eſpy any one Angle.

As for Example: Let be D: Note then what Degrees upon the Limb are cut by the Index, which let be 10 deg. Mark this down in your Field-Book, and when you have protracted as before directed, lay the Centre of your Protractor upon any Place of the Line F D, as at ⊙, turning the Protractor about till to 10 deg. lie directly upon the Line F D. Then againſt the End of the Diameter of the Protractor make a Mark as at N, and draw the Line N ⊙, which is a Meridian, or North and South Line, by which you may make a Compaſs. *Note*,

Note, That you may as well take the Plot of a Field at one Station, ſtanding in any Side thereof, as in an Angle: For if you had ſet your Inſtrument in *a*, the Work would be the ſame. I ſhall forbear therefore (as much as I may) Tautologies.

How to take the Plot of a Field at two Stations, provided from either Station you may ſee every Angle, and meaſuring only the ſtationary Diſtance.

Let C D E F G H be ſuppoſed a Field to be meaſured at two Stations: Firſt, when you come into the Field, make choice of two Places for your Stations, which let be as far aſunder as the Field will conveniently admit of; alſo take care that if the ſtationary Diſtance were continued, it would not touch any Angle of the Field; then ſetting the Semicircle at A, the firſt Station, turn it about, the North Point from you, till through the fixed Sights you eſpy the Mark at your ſecond Station, which admit to be at B, there ſcrew faſt the Inſtrument; then turn the moveable Index to every ſeveral Angle round the whole Field, and ſee what



what Degrees are cut thereby at every Angle, which note down in your Field-Book, as followeth:

Angles.

Angles.	Degr.	Min.
C	24	30
D	97	00
E	225	00
F	283	30
G	325	00
H	346	00

Firſt Station.

Secondly, Meaſure the Diſtance between the two Stations, which let be 20 Chains, and ſet it down in the Field-Book.

Stationary Diſtance 20 *Chains*, 00 *Links.*

Thirdly, Placing the Inſtrument at B, the ſecond Station, look backwards through the fixed Sights to the firſt Station at A, (I mean by looking backward, that the South Part of the Inſtrument be towards A) and having eſpied the Mark at A, make faſt the Inſtrument, and moving the Index as you did at the firſt Station to each Angle, ſee what Degrees are cut by the Index, and note them down as followeth; and then have you done, unleſs you will take a Meridian Line before you move the Inſtrument; which you were taught to do a little before.

Angles.	Degr.	Min.
C	84	00
D	149	00
E	194	00
F	215	00
G	270	00
H	322	00

The Second Station.

How to protract or lay down upon Paper theſe following Obſervations.

Firſt, Draw a Line croſs your Paper at pleaſure, as the Line I K; then take from off the Scale the ſtationary Diſtance 20 Chains, and ſet it upon that Line, as from A to B, ſo will A repreſent the firſt Station, B the ſecond.

Secondly, Apply the Centre of your Protractor to the Point A, and the Diameter lying ſtrait upon the Line B K; mark out round it the Angles, as you find them in the Field-Book, and through thoſe Marks from A draw Lines of a convenient Length.

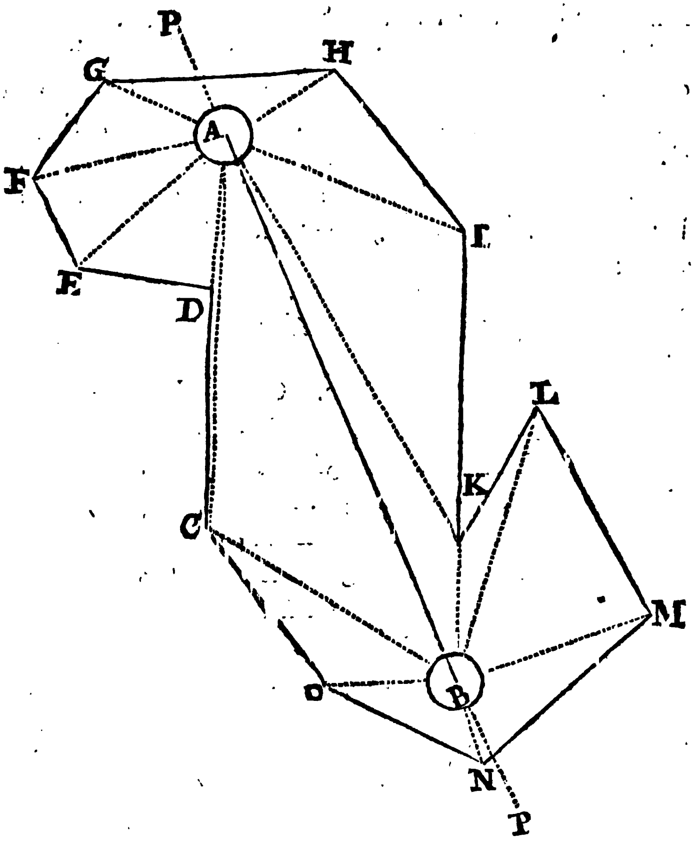
Thirdly, Move your Protractor to the ſecond Station B; and there mark out your Angles, and draw Lines, as before at the firſt Station.

Laſtly, The Places where the Lines of the firſt Station, and the Lines of the ſecond interſect each other, are the Angles of the Field. As for Example:

At the firſt Station the Angle C was 24 Degrees 30 Minutes, through thoſe Degrees I draw the Line A C. At the ſecond Station C was 84 Degrees; accordingly from the ſecond Station I draw the Line B 2: Now, I ſay, where theſe two Lines cut each other, as they do at C, there is one Angle of the Field. So likewiſe of D E, and the reſt of the Angles; if therefore between theſe Interſections you draw ſtrait Lines, as C D, D E, E F, *&c.* you will have a true Figure of the Field.

This may as well be done by taking two Angles for your Stations, and meaſuring the Line between them, as C and D; from whence you might as well have ſeen all the Angles, and conſequently as well have performed the Work.

How to take the Plot of a Field at two Stations, when the Field is ſo irregular, that from one Station you cannot ſee all the Angles.



Let CDEFGHIKLMNO be a Field, in which from no one Place thereof all the Angles may be ſeen; chuſe therefore two Places for your Stations, as A and B; and ſetting the Semicircle in A, direct the Diameter to the ſecond Station B; there making the Inſtrument faſt, with the Index take all the Angles at that End of the Field, as CDEFGHIK, and meaſure the Diſtance between your Inſtrument and each Angle; meaſure alſo the Diſtance between the two Stations A and B.

Secondly, Remove your Inſtrument to the ſecond Station at B; and having made it faſt, ſo as that thro' the Back-ſights you may ſee the firſt Station A, take the Angle at that End of the Field, as NOCKLM, and meaſure their Diſtances alſo as before; all which done, your Field-Book will ſtand thus:

Firſt Station.

Angles.	Degr.	Min.	Chains.	Links.
C	25	00	20	75
D	31	00	8	10
E	67	00	9	85
F	101	00	10	80
G	137	00	7	00
H	262	00	6	70
I	316	00	13	70
K	354	00	24	50

The Diſtance between the two Stations, 31 Chains, 60 Links.

Second

Second Station.

Angles.	Degr.	Min.	Chains.	Links.
N	3	30	4	20
O	111	00	7	00
C	145	00	15	60
K	205	00	7	48
L	220	00	15	00
M	274	00	11	20

To lay this down upon Paper, draw at adventure the Line P B A P; then taking in with the Compaſſes the Diſtance between the two Stations, *viz.* 31 Chains, 60 Links; ſet it upon the Line, making Marks with the Compaſſes, as A and B; A being the firſt Station, B the ſecond, lay the Protractor to A, the North-end of the Diameter towards B, and mark out the ſeveral Angles obſerved at your firſt Station, drawing Lines, and ſetting off the Diſtances, as you were taught in the Beginning of this Chapter, *Fig.* 1.

Do the ſame at B, the ſecond Station; and when you have marked out all the Diſtances between thoſe Marks, draw the Bound-lines.

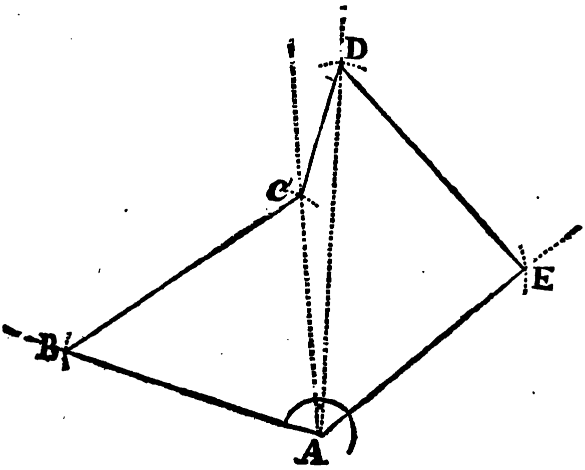
I am the briefer in this, becauſe it is the ſame as was taught concerning *Fig.* 1.; for if you conceive a Line to be drawn from C to K, then would there be two diſtinct Fields to be meaſured at one Station a-piece.

If a Field be very irregular, you may after the ſame manner make three, four, or five Stations, if you pleaſe; but I think it better to go round ſuch a Field, and meaſure the bounding Lines thereof: Which by and by I ſhall ſhew you how to do.

Note, In the foregoing Figure you might as well have had your Stations in two convenient Angles, as D and K, and have wrought as you were taught concerning *Fig.* 2. the Work would have been the ſame.

How to take the Plot of a Field at one Station in an Angle (ſo that from that Angle you may ſee all the other Angles) by meaſuring round about the ſaid Field.

ABCDE is the Field, and A the Angle appointed for the Station; place your Semicircle in A, and direct the Diameter thereof, till through the fixed Sights you ſee the Mark at B; then ſcrew it faſt, and turn the Index to C, obſerving what Degrees are there cut upon the Limb; which let be 68 Degrees: Turn it further, till you eſpy D, and note down the Degrees there cut, *viz.* 76 Degrees;



Degrees; do the like at E, and the Index will cut 124 Degrees: This done, meaſure round the Field, noting down the Length of the Side-lines between Angle and Angle, as from A to B, 14 Chains, 00 Links; from B to C, 15 Chains, 00 Links; from C to D, 7 Chains, 00 Links; from D to E, 14 Chains, 40 Links; and from E to A, 14 Chains, 5 Links.

Then will your Field-Book be as hereunder.

Angles.	Degr.	Min.
C	68	00
D	76	00
E	124	00

Links.	Chains.	Links.
A B	14	00
B C	15	00
C D	7	00
D E	14	40
E A	14	5

To protract which, draw the Line A B at adventure; and applying the Centre of the Protractor to A, (the Diameter lying upon the Line A B, and the Semicircle of it upwards) prick off the Angle, as againſt 68 : 76 : and 124 : make Marks, through which Marks draw the Lines A C, A D, A E, long enough be ſure; then take in with your Compaſſes, from off the Scale, the Length of the Line A B, *viz.* 14 Chains, and ſetting one Foot of the Compaſſes in A, with the other croſs the Line, as at B; alſo for B C take in 15 Chains, and ſetting one Foot in B, with the other croſs the Line A C, which will fall to be at C; for the Line C D take in 7 Chains, and ſetting one Foot in C, croſs the Line A D, *viz.* at D; then for D E, take in 14 Chains, 40 Links, and ſetting one Foot of the Compaſſes in DE, with the other croſs the Line AE, which will fall at E. Laſtly, for EA take 14 Chains 5 Links with your Compaſſes, and ſetting one Point in E, ſee if the other fall exactly upon A; if it does, you have done the Work true; if not, you have erred; between the Croſſes or Interſections, draw ſtrait Lines, which ſhall be the Bounds of the Field, *viz.* AB, BC, CD, DE, EA.

How to take the Plot of the foregoing Field, by meaſuring one Line only, and taking Obſervations at every Angle.

Begin as you have been juſt before taught, till you have taken the Angles CDE, *viz.* 68, 76, and 124 Degrees; then leaving a good Mark at A, which may be ſeen all round the Field, go to B, meaſuring as you go the Diſtances from A to B, which is all the Lines you need to meaſure; and planting your Semicircle at B, direct the South Part thereof toward A, until through the back fixed Sights you ſee the Mark at A; there making it faſt, turn the Index about till you eſpy C, and note down the Degrees there cut, which let be 129 Degrees; move your Inſtrument to C, and ſtill keeping the South Part of the Diameter to A, turn the Index to D, where it will cut 20 Degrees; then remove to D, and eſpying A through the Back-ſights, turn the Index to E, where it will cut 135 Degrees. Note all this in your Field-Book.

Angles

Angles taken at the firſt Station.		*Angles round the Field.*	
C— 68	Degrees.	B . 129	Degrees.
D— 76		C . 20	
E—124		D . 135	

Line A B : 14 Chains.

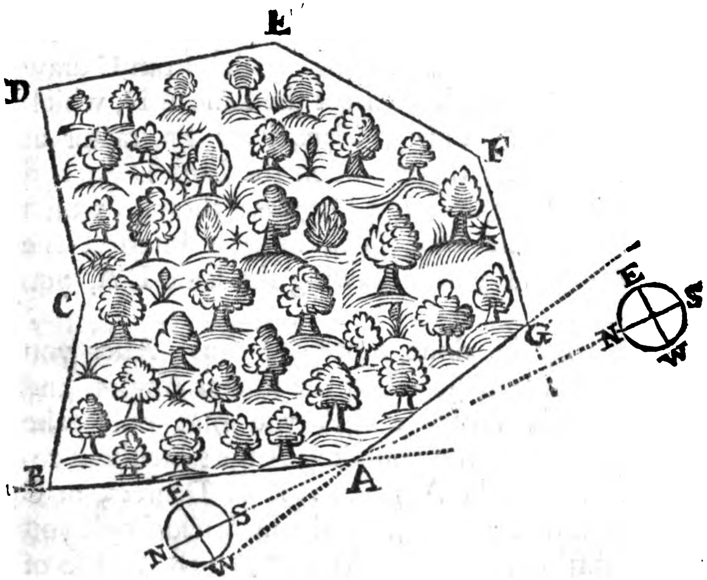
To protract this, you muſt work as you were taught concerning the foregoing Figure, until you have drawn the Lines A B, A C, A D, A E, and ſet off the Line A B, 14 Chains; then laying the Centre of your Protractor to B, and the South-end of the Diameter (or that marked with 180 Degrees) towards A, make a Mark againſt 129 Degrees, and through that Mark from B, draw the Line B C, till it interſect the Line A C, which it will do at C. Lay alſo the Centre of the Protractor upon C, the Diameter thereof upon A C; and againſt 20 Degrees make a Mark, through which from C draw the Line C D, till it interſect the Line A D, which it will do at D. Laſtly, Place your Protractor at D, the Diameter thereof upon the Line D A, and make a Mark againſt 135 Degrees; through which Mark draw the Line D E, until it interſect the Line A E at E; alſo drawing the Line E A, you have done.

This may be done otherwiſe thus: After you have, ſtanding at A, taken the ſeveral Angles, and meaſured the Diſtance A B, you may only take the Quantity of the bounding Angles, without reſpect to A; as the Angle at B is 51 Degrees, at C (an outward Angle, which in your Field-Book you ſhould diſtinguiſh with a Mark ⌝) 138, and ſo of the reſt. And when you come to Plot, having found the Place for B, there make an Angle of 51 Degrees, drawing the Line till it interſect A C, &c.

You may alſo ſurvey a Field after this manner, by ſetting up a Mark in the middle thereof, and meaſuring from that to any one Angle; alſo in the Obſervations round the Field, having reſpect to that Mark, as you had here to the Angle A.

It is too tedious to give Examples of all the Varieties; beſides, it would rather puzzle than inſtruct a Neophyte.

How to take the Plot of a large Field or Wood, by meaſuring round the ſame, and taking Obſervations at every Angle thereof by the Semicircle.



Suppoſe A B C D E F G to be a Wood, through which you cannot ſee to take the Angles, as before directed, but muſt be forced to go round the ſame; firſt plant the Semicircle at A, and turn the North-end of the Diameter about, till through the fixed Sights you ſee the Mark at B; then move round the Index, till through the Sights thereof you eſpy G, the Index there cutting upon the Limb 146 Degrees.

2. Remove to B; and as you go, meaſure the Diſtance A B, *viz.* 23 Chains, 40 Links; and planting the Inſtrument at B, direct the North-end of the Diameter to C, and turn the Index round to A, it then pointing to 76 Degrees.

3. Remove to C, meaſuring the Line as you go, and ſetting your Inſtrument at C, direct the North-end of the fixed Diameter to D, and turn the Index till you eſpy B, and the Index then cutting 205 Degrees; which, becauſe it is an outward Angle, you may mark thus 7 in your Field-Book.

4. Remove to D, and meaſure as you go; then placing the Inſtrument at D, turn the North-end of the Diameter to E, and the Index to C, the Quantity of the Angle will be 84 Degrees.

And thus you muſt do at every Angle roued the Field, as at E, you will find the Quantity of that Angle to be 142 Degrees, F 137, G 110: But there is no need for your taking the laſt Angle, nor yet meaſuring the two laſt Sides, unleſs it be to prove the Truth of your Work; which is indeed convenient. When you have thus gone round the Field, you will find your Field-Book to be as followeth:

Angles,

	Angles.			Links.	
	Deg.	Min.		Ch.	Link.
A	146	00	AB	23	40
B	76	00	BC	15	20
C	205	00 7	CD	17	90
D	84	00	DE	20	60
E	137	00	EF	13	60
G	110	00	GA	19	28

To protract this, draw a dark Line at adventure, as A B; upon which ſet off the Diſtance, as you ſee in your Field-Book, 23 Chains, 40 Links, from A to B; then laying the Centre of your Protractor upon A, and the Diameter upon the Line A B, the North-end, or that of 00 Degrees towards B; on the Outſide of the Limb make a Mark againſt 146 Degrees, thro' which Mark from A draw the Line A G; ſo have you the firſt Angle and firſt Diſtance.

2. Place the Centre of the Protractor upon B, and turn it about till 76 Degrees lies upon the Line A B; there hold it faſt, and againſt the North-end of the Diameter make a Mark, thro' which draw a Line, and ſet off the Diſtance B C, 15 Chains, 20 Links.

3. Apply the Centre of the Protractor to C, (the Semicircle thereof outward, becauſe you ſee by the Field-Book it is an outward Angle) and turn it about till 205 Degrees lie upon the Line C B; then againſt the Upper or South-end of the Diameter make a Mark, through which draw a Line, and ſet off 17 Chains, 90 Links from C to D.

4. Put the Centre of the Protractor to D, and make 84 Degrees thereof lie upon the Line CD; then making a Mark at the End of the Diameter, or 0 *degr.* through that Mark draw a Line, and ſet off 20 Chains, 60 Links, *viz.* DE.

5. Move the Protractor to E, and make 142 *degr.* to lie upon the Line ED. Then at the End of the Protractor make a Mark as before, and ſetting off the Diſtance 18 Chains, 85 Links, draw the Line EF.

6. Lay the Centre of the Protractor upon F, and making 137 *degr.* lie upon the Line EF; againſt the End of the Diameter make a Mark, through which draw the Line FG, which will interſect the Line AG at G: So have you a true Copy of the Field or Wood. But you may, if you think fit to prove your Work, ſet off the Diſtance from F to G; and at G apply your Protractor, making 110 *degr.* thereof to lie upon the Line FG. Then if the End of the Diameter point directly to A, and the Diſtance be 90 Chains, 28 Links, you may be ſure you have done your Work true.

Whereas I bid you put the North-end of the Inſtrument and of the Protractor towards B, it was chiefly to ſhew you the Variety of Work by one Inſtrument; for in the Figure before this, I directed you to do it the contrary way; and in this Figure, if you had turned the South-end of the Inſtrument to G, and with the Index had taken B, and ſo of the reſt, the Work would have been the ſame; remembring ſtill to uſe the Protractor the ſame way as you did your Inſtrument in the Field.

Alſo if you had been to have ſurveyed this Field or Wood by the Help of the Needle; after you had planted the Semicircle at A, and poſited it, ſo that the Needle might hang directly over the *Flower-de-luce* in the Card, you ſhould have turned the Index to B, and put down in your Field-Book what Degrees upon the Braſs Limb had then been cut thereby, which let be 20. Then moving your Inſtrument to B, make the Needle hang over the *Flower-de-luce*, and turn the Index to C, and note down what Degrees are there cut. So do by all the reſt of the Angles. And when you come to protract, you muſt draw Lines parallel to one another croſs the Paper, not farther diſtant than the Breadth of the Parallelogram of your Protractor; which ſhall be Meridian Lines, marking one of them at one End N. for the North, and at the other S. for South. This done, chuſe any Place which you ſhall think moſt convenient upon one of the Meridian Lines for your firſt Angle at A; and laying the Diameter of your Protractor upon that Line; againſt 20 *degr.* make a Mark; through which draw a Line, and upon it ſet off the Diſtance from A to B.

In like manner proceed with the other Angles and Lines, at every Angle laying your Protractor parallel to a North and South Line; which you may do by the Figures graduated thereon, at either End alike.

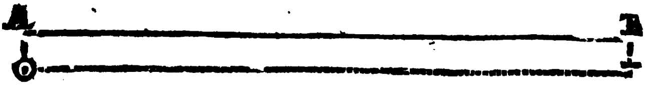
When you have ſurveyed after this manner, how to know, before you go out of the Field, whether you have wrought true or not.

Add the Sum of your Angles together, as in the Example of the precedent Wood, and they make 900. Multiply 180 by a Number leſs by two than the Number of Angles; and if the Product be equal to the Sum of the Quantity of all the Angles, then have you wrought true. There were ſeven Angles in that Wood, therefore multiply 180 by 5, and the Product is 900.

If you ſurvey, by taking the Quantity of every Angle, and if all be inward Angles, you muſt work as before. But if one or more be outward Angles, you muſt ſubtract them out of 180 *degr.* and add the Remainder only to the reſt of the Angles. And when you multiply 180 by a Sum leſs by 2 than the Number of your Angles, you are not to account the outward Angles into the Number. Thus, in the precedent Example, I find one outward Angle, *viz.* C 205; the Quantity of which, if it had been taken, would have been but 155 *degr.* That taken from 180 *degr.* there remains 25; which I add to the other Angles, and they make then in all 720. Now becauſe C was an outward Angle, I take no notice of it; but ſee how many other Angles I have, and I find 6: a Number leſs by two than 6, is 4; by which I multiply 180, and the Product is 720, as before.

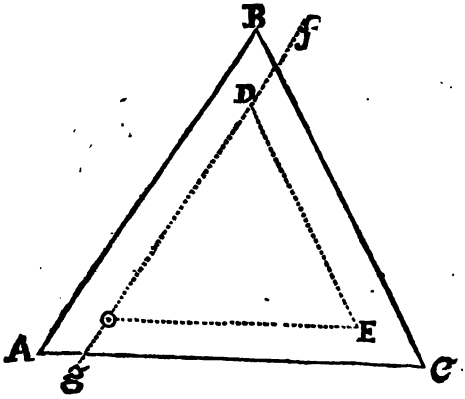
Directions to meaſure parallel to a Hedge, (when you cannot go in the Hedge itſelf); and alſo, in ſuch Caſe, how to take your Angles.

It is impoſſible for you, when you have a Hedge to meaſure, to go at top of the Hedge itſelf; but if you go parallel thereto, either within or without, and make your Parallel-line of the ſame Length as the Line of your Hedge, your Work will be the ſame. Thus, if A B was a buſhy Hedge, to which



you could not conveniently come nigher to plant your Inſtrument than ⊙; let him that goes to ſet up your Mark at B, take before he goes the Diſtance A ⊙, which he may do readily with a Wand or Rod; and at B let him ſet off the ſame Diſtance again, as to +, where let the Mark be placed for your Obſervation; and when the Chain bears, meaſure the Diſtance ⊙ +; be ſure they have reſpect to the Hedge A B, ſo as that they make ⊙ + equal to A B, or of the ſame Length.

But to make this more plain: Suppoſe A B C to be a Field; and for the Buſhes, you cannot come nigher than ⊙ to plant your Inſtrument. Let him

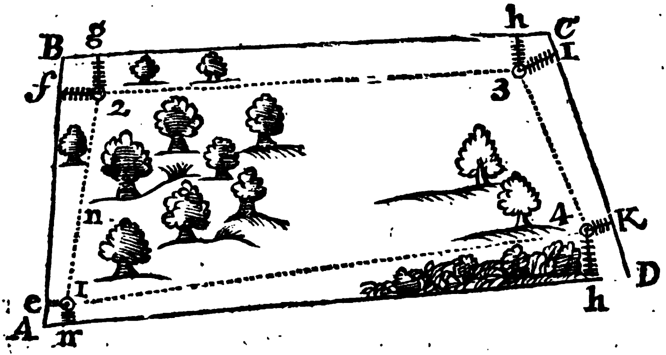


that ſets up the Marks take the Diſtance between the Inſtrument ⊙, and the Hedge AB; which Diſtance let him ſet off again nigh B, and ſet up his Mark at D;

likewiſe let him take the Diſtance between ⊙ and the Hedge A C, and accordingly ſet up his Mark at E. Then taking the Angle *d* ⊙ E, it will be the ſame as the Angle B A C: So do for the reſt of the Angles. But when the Lines are meaſured, they muſt be meaſured of the ſame Length as the outſide Lines, as the Line ⊙ *d* meaſured from *g* to *f*, *&c.* The beſt way therefore is for them that meaſure the Lines, to go round the Field on the Outſide thereof, although the Angles be taken within.

How to take the Plot of a Field or Wood, by obſerving near every Angle, and meaſuring the Diſtance between the Marks of Obſervation, by taking, in every Line, two Off-ſets to the Hedge.

Let A, B, C, D be a Wood or Field, to be thus meaſured. Cauſe your Aſſiſtants to ſet up Marks in



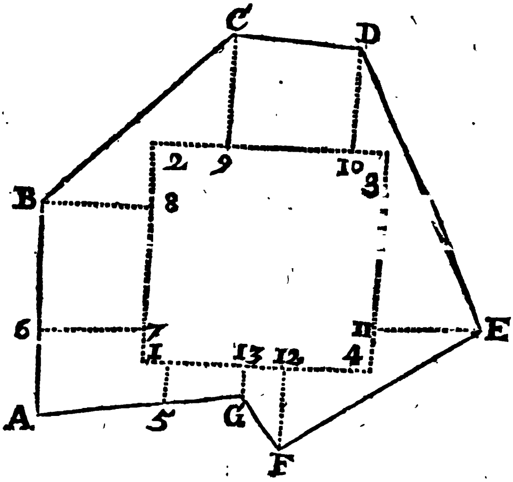
every Angle thereof, not regarding the Diſtance from the Hedges, ſo much as the Convenience for planting the Inſtrument, ſo as you may ſee from one Mark to another. Then beginning at ⊙ 1, take the Quantity of that Angle, and meaſure the Diſtance 1, 2. But before you begin to meaſure the Line, take the Off-ſet to the Hedge, *viz.* the Diſtance ⊙ *e*; and in taking of it, you muſt make that little Line ⊙ *e* perpendicular to 1, 2; which is eaſily done, when your Inſtrument ſtands with the fixed Sights towards 2, by turning the moveable Index till it lie upon 90 *degr.* which then will direct to what Place of the Hedge to meaſure, as *e*, that little Line ⊙ *e*, ſet down in your Field-Book under Title *Off-ſet.* So likewiſe when you come to 2, meaſure there the Off-ſet again, *viz.* ⊙ *f.* Then taking the Angle at 2, meaſure the Line 2, 3, and the Off-ſets 2 *g*, 3 *h*. The like do by all the reſt of the Lines and Angles in the Field, how many ſoever they be. And when you come to lay this down upon Paper; firſt, as you have been taught before, protract the Figures 1, 2, 3, 4. That done, ſet off your Off-ſets as you find them in the Field-Book, *viz.* ⊙ *e*, and ⊙ *f*, perpendicular to the Line 1, 2; alſo ⊙ *g*, ⊙ *h*, perpendicular to the Line 2, 3, making Marks at *e*, *f*, *g*, *h*, and the reſt; through which draw Lines that ſhall interſect each other at the true Angles, and deſcribe the true Bound-Lines of the Field or Wood.

In working after this manner, obſerve theſe two Things: Firſt, If the Wood be ſo thick, that you cannot go on the Inſide thereof, you may, after the ſame manner, as well perform the Work by going on the Outſide round the Wood.

Secondly, If the Lines are ſo long, that you cannot ſee from Angle to Angle, cauſe your Aſſiſtant to ſet up a Mark ſo far from you as you can conveniently ſee it, as at *n*. Meaſure the Diſtance ⊙ 1 *n*, and take the Off-ſet from *n* to the Hedge. Then at *n* turn the fixed Sights of the Inſtrument to ⊙ 1, and by that Direction proceed on the Line till you come to an Angle.

This Way of ſurveying is much eaſier done (though I cannot ſay truer) by taking only a great Square in the Field; from the Sides of which the Off-ſets are taken.

I have drawn this following Figure ſo, that at once you may ſee all the Variety of this way of Working. The beſt Way indeed is to contrive



your Square ſo, that, if poſſible, you may from the Sides thereof go upon a perpendicular Line to any of the Angles. But if that cannot be, then perpendicular Lines to the Sides may do as well, as you ſee here, 1, 5, 7, 6, to be. To begin therefore, plant your Semicircle in any convenient Place of the Field, for taking a large Square as at 1; and laying the moveable Index upon 90 *degr.* look through the Sights, and cauſe a Mark to be ſet up in that Line, as at 4: Looking alſo through the fixed Sights, cauſe another Mark to be ſet up, as at 2. Meaſure out from your Inſtruments towards either of theſe Marks, any Number of Chains, as from 1 to 2, 12 Chains; from 2 to 4, 12 Chains. But as you meaſure, remember to take the Off-ſets in a perpendicular Line to every Angle or Side, if there be occaſion, as here 7, which is 1 Chain, 50 Links; from my Stations I take an Off-ſet to a Side of the Hedge, and put it down accordingly 5 Chains, 40 Links. So at 8 I take an Off-ſet to an Angle, *viz.* 8 B, 6 Chains; which Off-ſet is at the End of 8 Chains, 30 Links in my firſt Line. Then ſeeing in that Line there is no more occaſion of Off-ſets, I meaſure on to 2, making the Line 1, 2, 12 Chains. Then planting my Inſtrument at 2, I direct the fixed Sights to my firſt Station, and laying the Index upon 90 *degr.* I cauſe a Mark to be ſet up, ſo as that I may ſee it through the Sights; and upon that Line, as I meaſure out 12 Chains, I take the Off-ſets C 9, D 10. In like manner you muſt do for the other Angle, Lines, and Off-ſets.

And when you have thus laid out your Square, and taken all your Off-ſets, you will find in your Field-Book ſuch *Memorandums* as theſe, to help you to protract.

The Angles 4 *Right Angles.*
The Sides 12 *Chains,* 00 *Links each.*

I went round *cum Sole*, or the Hedges being on my Left-hand.

	C.	L.		C.	L.
In the firſt Line, at	1	50	Off-ſet to a Side-line	5	40
	8	30	Off-ſet to an Angle	6	00

	C.	L.		C.	L.
In the ſecond Line, at	3	50	Off-ſet to an Angle	6	00
	10	70	Off-ſet to an Angle	5	50

	C.	L.		C.	L.
In the third Line, at	10	90	Off-ſet to an Angle	5	30

	C.	L.		C.	L.
In the fourth Line, at	4	33	Off-ſet to an Angle	4	40
	6	70	Off-ſet to an Angle	1	50
	10	80	Off-ſet to a Side	2	20

Now to lay down upon Paper the foregoing Work, make firſt a ſquare Figure, whoſe Side may be 12 Chains, as 1, 2, 3, 4. Then conſidering you went with the Sun, take 1, 2 for the firſt Line; and taking from your Scale 1 Chain, 50 Links, ſet it upon the Line from 1 to 7; at 7 raiſe a Perpendicular, as 7, 6, making it according to your Field-Book, 5 Chains, 40 Links long. Alſo for the ſecond Off-ſet upon the ſame Line, take from your Scale of equal Parts 8 Chains, 30 Links, which ſet upon the Line from 1 to 8, and upon 8 make the perpendicular Line 8 B, 6 Chains in Length.

For the Off-ſets of the ſecond Line, take 3 Chains, 50 Links from the Scale, and ſet it from 2 to 9; at 9 make a perpendicular Line 6 Chains long, *viz.* 9 C: Alſo for the ſecond Off-ſet of the ſame Line, take 10 Chains, 70 Links, and ſet it from 2 to 10; at 10 make the Perpendicular 10 D, 5 Chains, 50 Links in Length.

For the Off-ſets of the third Line, take from your Scale 10 Chains, and ſet it up from 3 to 11; and at 11 make the Perpendicular 11 E, 5 Chains, 30 Links long.

For the Off-ſets of the fourth Line, take from your Scale 4 Chains, 30 Links, and ſet it from 4 to 12; and at 12 make the Perpendicular 12 F, 4 Chains, 40 Links long. Alſo take 6 Chains, 70 Links, and ſet it from 4 to 13; and at 13 make the Perpendicular 13 G, 1 Chain, 50 Links long.

Laſtly, Take 10 Chains, 80 Links, and ſet it from 4 to I; and at I, make the Perpendicular I, 5, 2 Chains, 20 Links long.

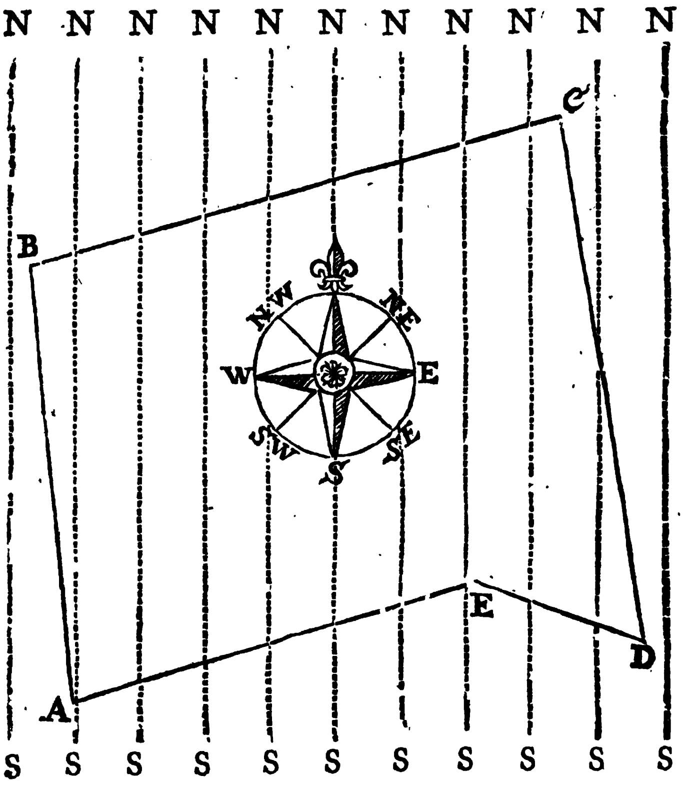
Then have you no more to do, but through the Ends of theſe Perpendiculars to draw the Bounding-lines, remembring to make Angles where the Field-Book mentions Angles; and where it mentions Side-lines, there to continue ſuch Side-lines till they meet in an Angle.

Although I mention a Square, yet you are not bound to that Figure; for you may with the ſame Succeſs uſe a Parallelogram, Triangle, or any other Figure. Nor are you bound to take the Off-ſets in perpendicular Lines, although it be the beſt Way; for you may take the Angles with the Index from any Part of the Line.

This Way was chiefly intended for ſuch as were not provided with Inſtruments; for inſtead of the Semicircle with a plain Croſs only, you may lay out a Square, the reſt of the Work being done with a Chain.

How by the Help of the Needle to take the Plot of a large Wood by going round the ſame, and making uſe of that Diviſion of the Card that is number'd with four 90ˢ or Quadrants.

Let A B C D E repreſent a Wood; ſet your Inſtrument at A, and turn it about till through the fixed Sights you eſpy B, then ſee what Degrees in the Diviſion before ſpoken of, the Needle cuts; which let be N 7 W, meaſure A B 27 Chains, 70 Links; then ſetting the Inſtrument at B, direct the Sights to C, and ſee what then the Needle cuts, which let be N 74 E; meaſure B C 39 Chains, 50 Links; in like manner meaſure every Line, and take every Angle, and then your Field-Book will ſtand thus, as followeth hereunder.



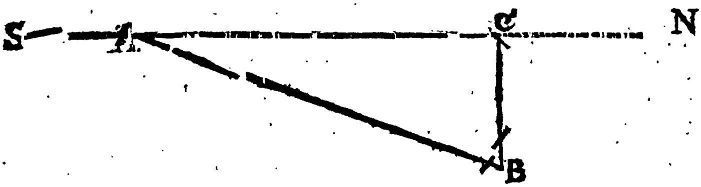
Lines.		Degrees.	Minutes.	Chains.	Links.
AB	NW	7	00	28	20
BC	N E	74	00	39	50
CD	S E	9	00	38	00
DE	NW	63	20	14	55
EA	S W	74	80	28	60

To lay down which upon Paper, draw parallel Lines through your Paper, which ſhall repreſent Meridians, or North and South Lines, as the Lines N S N S; then applying the Protractor (which ſhould be graduated accordingly with twice 90 Degrees, beginning at each End of the Diameter, and meeting in the Middle of the Arch) to any convenient Place of one of the Lines as to A, lay the Meridian Line of the Protractor to the Meridian Line on the Paper, and againſt 7 *deg.* make a Mark, through which draw a Line, and ſet off thereon the Diſtance AB 28 Chains, 20 Links. *Secondly*, Apply the Centre of the Protractor to B, and (turning the Semicircle thereof the other way, becauſe you ſee the Courſe tends to the Eaſtward) make the Diameter thereof lie parallel to the Meridian Lines on the Paper, (which you may do by the Figures at the Ends of the Parallelogram) and againſt 74 Degrees make a Mark, and ſet off 39 Chains, 50 Links, and draw the Line B C; the like do by the other Lines and Angles, until you come round to the Place where you began.

This is the moſt uſual Way of plotting Obſervations taken after this manner, and uſed by moſt Surveyors in *America*, where they lay out very large Tracts of Land: But there is another Way, though more tedious, yet ſurer; (I think firſt made publick by Mr. *Norwood*) whereby you may know before you come out of the Field, whether you have taken your Angles, and meaſured the Lines truly or not, and is as followeth:

When you have ſurveyed the Ground as above directed, and find your Field-Book to ſtand as before; caſt up what Northing, Southing, Eaſting or

Weſting every Line makes; that is to ſay, How far at the End of every Line you have altered your Meridian, and what Diſtance upon a Meridian Line you have made. As for Example: Suppoſe A B was the Side of a Field meaſured to be 20 Chains, N S a Meridian Line, the Angle C A B



North 20 *deg.* Eaſt. The Buſineſs is to find the Length of the Line A C, which is called the Northing, or the Difference of Latitude; alſo the Length of the Line C B, which is called the Eaſting, or Difference of Longitude; which you may do indifferently true by laying them down thus upon Paper. But paſſing this and the *Gunter*'s Scale, the only way is by the Tables of Sines and Logarithms, where the Proportion is this:

As Radius or Sine of 90 Degrees, *viz.* the right Angle C is to the Logarithm of the Line A B 20 Chains;

So is the Sine of the Angle C A B 20 Degrees to the Difference of Longitude C K 6 Chains, 80 Links.

Secondly, To find the Difference of Latitudes, or the Line A C, ſay,

As Radius is to the Logarithm of the Line A B 20 Chains, ſo is the Sine Complement of the Angle at A to the Logarithm of the Line A C 18 Chains, 80 Links.

Example of the foregoing Figure.

In the precedent Figure, I find in my Field-Book the firſt Line to run N. W. 7 Degrees, 28 Chains, 20 Links; now to find what Northing, and what Weſting is here made, I ſay thus:

As Radius	10,000000
Is to the Logarithm of the Line 28 Chains, 20 Links,	1,450249
So is the Sine of the Angle from the Meridian, *viz.* 7 Degrees,	9,085894
To the Logarithm of the Weſting 3 Chains, 43 Links,	10,536143

Again,

As Radius	10,00000
Is to the Logarithm 28 Chains, 20 Links	1,450249
So is the Sine Complement of 7 Degrees	9,996751
To the Logarithm of the Northing 27 Chains, 99 Links,	1,1447000

And having thus found the Northing and Weſting of that Line, I put it down in the Field-Book againſt the Line under the proper Titles N. W. in like manner I find the Latitude and Longitude of all the reſt; and having ſet them down, the Field-Book will appear thus:

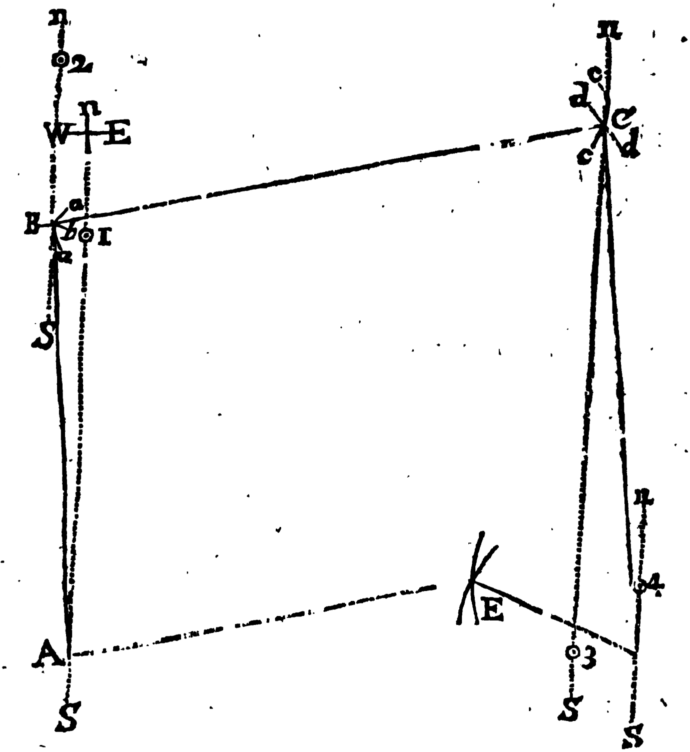
Lines.	Degrees.	Minutes.	Chains.	Links.	N	S	E	W
AB . NW	7	00	28	20	27 : 99	.. : ..	.. : ..	03 : 43
BC . N E	74	00	39	50	10 : 86	.. : ..	37 : 97	.. : ..
CD . S E	9	00	38	00	.. : ..	37 : 53	05 : 95	.. : ..
DE . N W	63	20	14	55	06 : 53	.. : ..	.. : ..	13 : 00
EA . S W	74	00	28	60	.. : ..	07 : 88	.. : ..	27 : 49
					45 : 41	45 : 41	43 : 92	43 : 92

This done, add the Northings together, alſo all the Southings, and ſee if they agree; alſo all the Eaſtings and Weſtings; and if they agree likewiſe, then you may be ſure you have wrought truly, otherwiſe not. Thus in this Example the Sum of the Northings is 45 Chains, 41 Links; ſo likewiſe is the Sum of the Southings; alſo the Sum of the Eaſtings is 43 Chains, 92 Links, ſo is the Sum of the Weſtings: therefore, I ſay, I have ſurveyed that Piece of Land true.

But becauſe this Way of caſting up the Northing, Southing, Eaſting or Weſting of every Line, may ſeem tedious and troubleſome to you; I have, at the End of this Book, made a Table, wherein by Inſpection only, you may find the Longitude and Latitude of every Line, what Quantity of Degrees ſoever it is ſituated from the Meridian.

Another Way of plotting the foregoing Piece of Ground according to the Table in the Field-Book of N S, E W, is as followeth:

Draw a Line at adventure, as the Line *n* ⊙ A S for a Meridian Line; then beginning in any place



of that Line, as at A, ſet off the Northing of the firſt Line, as from A to ⊙ 1, *viz.* 27 Chains, 99 Links; then taking with your Compaſſes the Weſtings of the ſame Line, *viz.* 3 Chains, 43 Links; ſet one Foot in ⊙ 1, and with the other make the Arch *a a*; next take the Length of your firſt Line, as you find it in the Field-Book, *viz.* 28 Chains, 20 Links; and ſetting one Foot of the Compaſſes in A, with the other croſs the former Arch *a a* with another, *viz.* B *b*, and in the Interſection of thoſe Arches, *viz.* at B, is your ſecond Angle.

Then through B draw another North and South Line parallel to the firſt, as *n* B S is parallel to N A S; and taking with your Compaſſes the Northing of the ſecond Line, *viz.* 10 Chains, 89 Links, ſet it up on the Line from B to ⊙ 2; take alſo the Eaſting of the ſame Line, *viz.* 37 Chains, 97 Links; and ſetting one Foot of the Compaſſes in ⊙ 2, with the other ſweep the Arch *c c*; alſo take with your Compaſſes the Length of the ſecond Line, *viz.* 39 Chains, 50 Links; and ſetting one Foot in B, croſs the former Arch with the other to *d d*; and that Interſection is your third Angle, *viz.* C.

It would be but Tautology in me to go round thus with all the Lines; for by theſe two firſt you may eaſily conceive how all the reſt are done. But let me put you in mind when you ſweep the Arches for the Eaſting and Weſting, to turn your Compaſſes the right way, and not take Eaſt for Weſt, and Weſt for Eaſt.

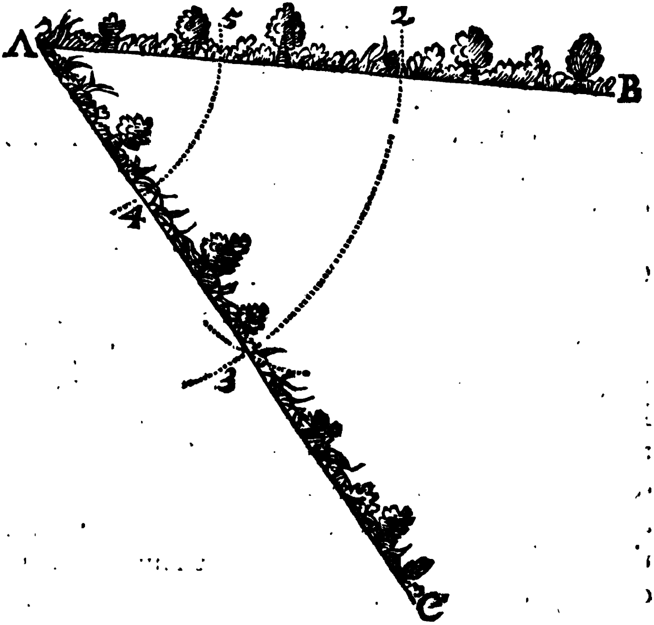
Nor can I commend to you this Way of Plotting, the former being as true, and far eaſier; yet when you plot by the former Way, it is very good for you to prove your Work by the Table of Difference of Latitude and Longitude before you begin to protract; and when you find your Field-Book true, you may lay it down upon Paper, which way you think the eaſieſt.

To conclude this Chapter or Section, I ſhall in the next place ſhew you, how to take the Plot of a Field by the Chain only, uſing no other Inſtrument in the Field; and that after a better manner than hitherto has been taught.

Firſt therefore I ſhall ſhew you how to take the Quantity of an Angle by the Chain; (which well underſtood) there need be no more required: For the Buſineſs of a Surveyor in the Field, is no more but to meaſure Sides and take Angles; I mean for telling the Quantity of any Field or Piece of Land, as how many Acres it contains, or the like.

How by the Chain only to take an Angle in the Field.

Firſt meaſure along the Hedge A B, any ſmall Diſtance, as A 2 two Chains; alſo meaſure along the

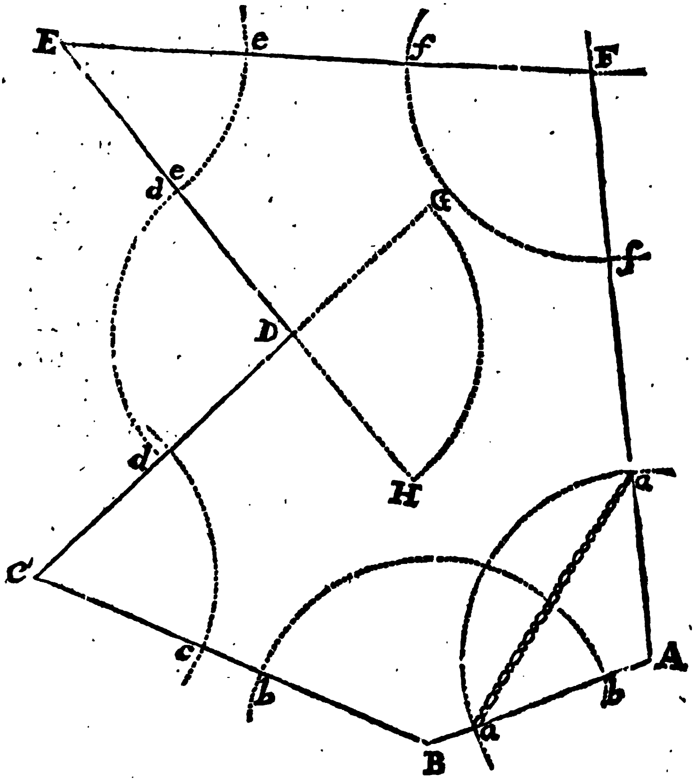


Hedge A C what Number of Chains you pleaſe, no matter whether they be equal to the former or not; as A 3 two Chains: Next meaſure the Diſtance 2, 3, *viz.* 1 Chain, 68 Links; and then have you done in the Field. To plot which, draw the Line A B at adventure, and ſet off 2 Chains from A to 2; then take with your Compaſſes the Diſtance A 3, 2 Chains, and ſetting one Foot in A, deſcribe the Arch 2, 3; take alſo with your Compaſſes the Diſtance 2, 3, *viz.* 1 Chain, 68 Links; and ſetting one Foot in 2, with the other croſs the former Arch; through which Croſs draw the Line A C; which with A B will make an Angle equal to the Angle in the Field.

But the more eaſy and ſpeedy Way is to take but one Chain only along the Hedges; as in the foregoing Figure, I ſet a ſtrong Stick in the very Angle A, and putting the Ring at one end of the Chain over it, I take the other end in my Hand, and ſtretch out the Chain along the firſt Hedge A B, and where it ends, as at 5, I ſtick down a Stick; then I ſtretch the Chain alſo along the Hedge A C, and at the end thereof ſet another Stick, as at 4; then looſing my Chain from A, I meaſure the Diſtance 4, 5, which is 74 Links, which is all that I need note down in my Field-Book for that Angle; and now coming to plot that Angle, I take firſt from my Scale the Diſtance of one Chain, and placing one Foot of the Compaſſes in any part of the Paper, as at A, I deſcribe the Arch 4, 5; then I take from the ſame Scale 74 Links, and ſet it off upon that Arch, making Marks where the Ends of the Compaſſes fall, as at 4, 5. *Laſtly*, From A; through theſe Marks I draw the Line A B, and A C, which conſtitute the former Angle: Remember to plot your Angles with a very large Scale; and you may ſet off your Lines with a ſmaller.

I will give you two *Examples* of this Way of meaſuring, and then leave you to your own Practice, Firſt,

How by the Chain only to ſurvey a Field by going round the ſame.



Let A B C D E F be the Field; and beginning at A in the very Angle, ſtick down a Staff through the great Ring at one of the Ends of your Chain, and taking the other End in your Hand, ſtretch out the Chain in length, and ſee in what Part of the Hedge A F the other End falls; as ſuppoſe at *a*, there ſet up a Stick; and do the like by the Hedge A B, and ſay there the Chain ends at (*a*) alſo: Meaſure the neareſt Diſtance between *a* and *a*, which let be 1 Chain, 60 Links; this note down in your Field-Book: Meaſure next the Length of the Hedge AB, which is 12 Chains, 50 Links; note this down alſo in your Field-Book. Next, coming to B, take that Angle in like manner as you did the Angle A, and meaſure the Diſtance B C: After this manner you muſt take all the Angles, and meaſure all the Sides round the Field. But leſt you be at a Nonplus at D, becauſe this is an outward Angle, thus you muſt do; Stick a Staff down with the Ring of the Chain round it in the very Angle D, then taking the other End of the Chain in your Hand, and ſtretching it at Length, move yourſelf to and fro, till you perceive yourſelf in a direct Line with the Hedge D C, which will be at G; where ſtick down an Arrow, or one of your Surveying-Sticks; then move round till you find yourſelf in a direct Line with the Hedge D E; and there, the Chain ſtretched out at length, plant another Stick, as at H; then meaſure the neareſt Diſtance, H G, which let be 1 Chain, 43 Links; which note down in your Field-Book, and proceed on to meaſure the Line D E; but in your Field-Book make ſome Mark againſt D, to ſignify it is an outward Angle, as ⁊, or the like. And when you come to plot this, you muſt plot the ſame Angle outward that you took inward; for the Angle G D H is the ſame as the Angle *d* D *d*. I made this outward Angle here on purpoſe to ſhew you how you muſt ſurvey a Wood, by going round it on the Outſide, where you muſt take moſt of the Angles, as here you do D.

Having thus taken all the Angles, and meaſured all the Sides; the next thing to be done, is to lay down upon Paper, according to your Field-Book: which you will find to ſtand thus:

	Croſs Lines or Chords.				
Angles.	Chains.	Links.	Lines of the Field.	Chains.	Links.
A	1	60	AB	12	50
B	1	84	BC	23	37
C	1	06	CD	19	30
D	1	43	DE	20	00
E	0	80	EF	29	00
F	1	52	FA	31	50

Foraſmuch now as it is convenient that the Angles be made by a greater Scale than the Lines are laid down with; I have therefore, in this Figure, made the Angles by a Scale of one Chain in an Inch, and laid down the Lines by a Scale of ten Chains in one Inch. But to begin to plot, take from your Scale one Chain; and with that Diſtance, in any convenient Place of your Paper, as at A, ſweep the Arch *a*, *a*; then from the ſame large Scale, take off 1 Chain, 60 Links, and ſet it upon that Arch, as from *a* to *a*; and from A draw the Lines through *a* and *a*, as the Lines A B, A F: Then repairing to your ſhorter Scale, take from thence the firſt Diſtance, *viz.* 12 Chains, 50 Links; and ſet from A to B, drawing the Line A B.

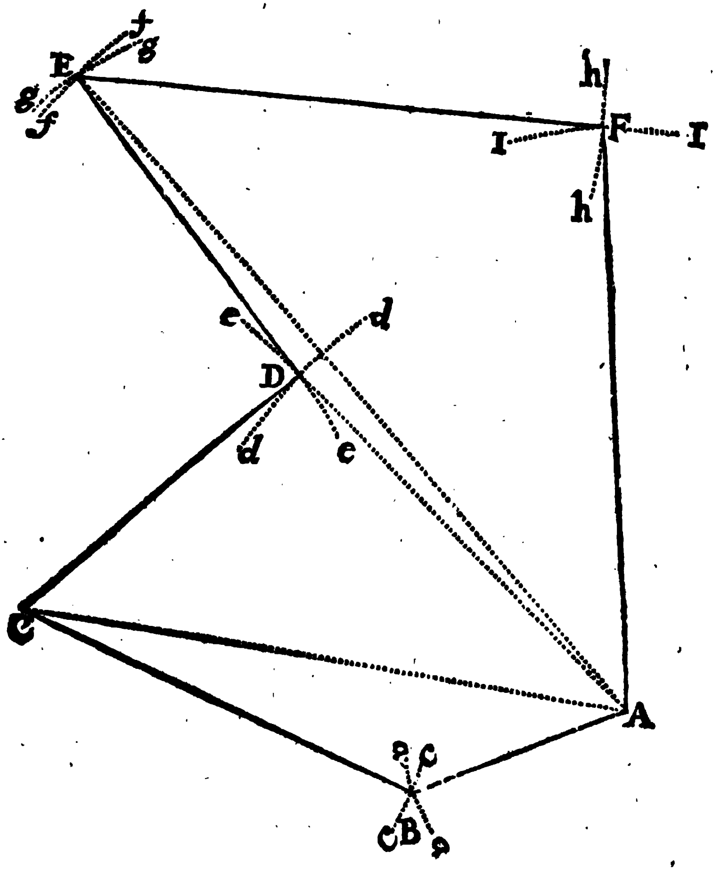
Secondly, Repairing to B, take from your large Scale 1 Chain, and ſetting one Foot of the Compaſſes in B, with the other make the Arch *b b*; alſo from the ſame Scale take your Chord-line, *viz.* 1 Chain, 84 Links, and ſet it upon the Arch *b b*, one Foot of the Compaſſes ſtanding where the Arch interſects A B, the other will fall at *b*; then thro' *b* draw the Line B C; and from your ſmaller Scale ſet off the Diſtance B C, 23 Chains, 37 Links; which will fall at C, where the next Angle muſt be made. After this manner proceed on according to your Field-Book, till you have done.

And here mark, That you need neither in the Field, nor upon the Paper, take notice of the Angle F, nor yet meaſure the Lines E F and A F; for if you draw thoſe two Lines through, they will interſect each other at the true Angle F: However, for the Proof of your Work, it is good to meaſure them, and alſo to take the Angle in the Field.

I muſt not let ſlip in this place the uſual Way taught by Surveyors, for the meaſuring of a Field by the Chain only; as true indeed as the former, but more tedious, which take as followeth.

The common Way taught by Surveyors for taking the Plot of the foregoing Field.

Becauſe I will not confound your Underſtanding with many Lines in one Figure, I have here again placed the ſame. Firſt, Meaſure round the Field, and note down in your Field-Book every Line thereof, as in this Field has been before done.



Secondly, Turn all the Field into Triangles, as beginning at A, to meaſure the Diagonal A C, A D, A E, and note them down; then is your Field turned into four Triangles, and the Diagonals are

	Chains.	Links.
AC	33	70
AD	25	70
AE	45	40

To plot which, firſt draw a Line at adventure, as the Line A C, and ſet off thereon 33 Chains, 70 Links, according to your Field-Book, for the Diagonals; then taking with your Compaſſes the Length of the Line A B, *viz.* 12 Chains, 50 Links, ſet one Foot in A, and with the other deſcribe the Arch *a a*; alſo take the Line B C, *viz.* 23 Chains, 37 Links, and ſetting one Foot in C, with the other deſcribe the Arch *c c*, cutting the Arch *a a* in the Point B; then draw the Lines AB, CB, which ſhall be the two Bound-lines of the Field.

Secondly, Take with your Compaſſes the Length of the Diagonal AD, *viz.* 25 Chains, 70 Links, and ſetting one Foot of the Compaſſes in A, with the other deſcribe the Arch, as *d d*; alſo taking the Line C D, *viz.* 19 Chains, 30 Links, ſet one Foot in C, and with the other deſcribe the Arch *e e*, cutting the Arch *d d* in the Point D, to which Interſection draw the Line C D.

Thirdly, Take with your Compaſſes the Length of the Diagonal A E, *viz.* 45 Chains, 40 Links; and ſetting one Foot in A, with the other deſcribe an Arch, as *ff*; alſo take the Line D E, 20 Chains, and therewith croſs the former Arch in the Point E, to which draw the Line D E.

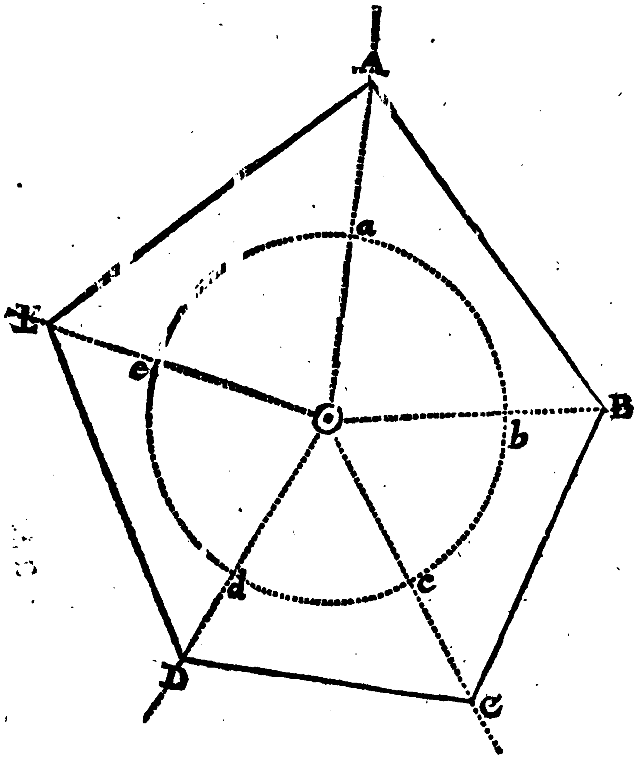
Laſtly, Take with your Compaſſes the Length of the Line A F, *viz.* 31 Chains, 50 Links; and ſetting one Foot in A, deſcribe an Arch, as I I. Alſo take the Length of the Line E F, *viz.* 29 Chains, 00 Links; and therewith deſcribe the Arch *b b*, which cuts the Arch I I in the Point F; to which Point draw the Lines A F and E F, and ſo will you have a true Figure of the Field.

I have ſhewed you both Ways, that you may take your Choice. And now I proceed to my ſecond Example promiſed.

How to take the Plot of a Field at one Station, near the Middle thereof, by the Chain only.

Let A B C D E be the Field, ⊙ the appointed Place, from whence by the Chain to take the Plot thereof. Stick a Stake up at ⊙ through one Ring of the Chain, and make your Aſſiſtant take the other End, and ſtretch it out. Then cauſe him to move up and down, till you eſpy him exactly in a Line between the Stick and the Angle A; there let him ſet down a Stick, as at *a*, and be ſure that the Stick *a* be in a direct Line between ⊙ and A; which you may eaſily perceive by ſtanding at ⊙, and looking to A. This done, cauſe him to move round towards B; and at the Chain's End, let him there ſtick down another Stick exactly in the Line between ⊙ and B, as at *b*. Afterwards let him do the ſame at *c*, at *d*, and at *e*; and if there were more Angles, let him plant a Stick at the End of the Chain in a right Line between ⊙ and every Angle. In the next place meaſure the nigheſt Diſtance between

Stick and Stick, as *a b*, 1 Chain, 26 Links; *b c*, 1 Chain, 6 Links; *c d*, 1 Chain, 0 Link; *d e*, 1 Chain, 20 Links; and put them down in your Field-Book accordingly. Meaſure alſo the Diſtances between ⊙ and every Angle, as ⊙ A, 18 Chains, 10 Links; ⊙ B, 15 Chains, 0 Links, &c. all which put down, your Field-Book will appear thus.



Subten-

		Ch.	Link.
Subtendent or Chord-Lines.	*ab*	1	26
	bc	1	06
	cd	1	00
	de	1	20

		Chain.	Link.
Diagonal or Centre Lines.	⊙ A	18	10
	⊙ B	15	00
	⊙ C	17	00
	⊙ D	15	00
	⊙ E	16	00

How to plot the former Obſervations.

Take from a large Scale 1 Chain, and ſetting one Foot of the Compaſſes in any convenient place of the Paper, as at ⊙, make the Circle *a b c d e*; then taking for your firſt Subtendent, or Chord-line, 1 Chain, 26 Links, ſet it upon the Circle, as from *a* to *b*. From ⊙ through *a* and *b* draw Lines, as ⊙ A, ⊙ B, which be ſure let be long enough. Then take your ſecond Subtendent from the ſame large Scale, *viz.* 1 Chain, 6 Links, and ſet it upon the Circle from *b* to *c*, and through *c* draw the Line ⊙ C. When thus you have ſet off all your Subtendents, and drawn Lines through their ſeveral Marks, repair to a ſmaller Scale; and upon the Lines drawn, ſet off your Diagonal or Centre-lines, as you find them in the Field-Book: So upon the Line ⊙ *a* you muſt ſet off 18 Chains, 10 Links, making a Mark where it falls, as at A; Upon the Line ⊙ *b*, 15 Chains, 0 Links, which falls at B; and ſo by all the reſt. Laſtly, Draw the Lines AB, BC, CD, *&c.* and the Work will be finiſhed.

It would be but running things over again, to ſhew you how after this manner to ſurvey a Field at two or three Stations, or in any Angle thereof, *&c.* For if you well underſtand this, you cannot be ignorant of the reſt.

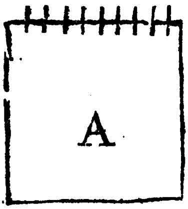
CHAP.

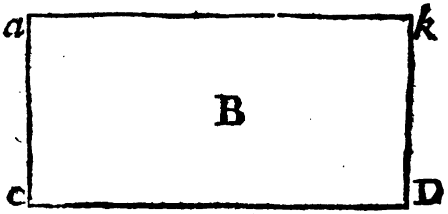
CHAP. VII.

How to caſt up the Contents of a Plot of Land.

HAving by this time ſufficiently ſhewed you how to ſurvey a Field, and lay down a true Figure thereof upon Paper; I come in the next place to teach you how to caſt up the Contents thereof; that is to ſay, to find out how many Acres, Roods and Perches it containeth. And firſt

Of the Square and Parallelogram.





To caſt up either of which, multiply one Side by the other, and the Product will be the Content.

EXAMPLE.

Let A be a true Square, each Side being 10 Chains; multiply 10 Chains, 0 Links, by 10 Chains, 0 Links, *facit* 10|00000; from which I cut off the five laſt Figures, and there remains juſt 10 Acres for the Square A.

Again; In the Parallelogram B, let the Side *Ab* or *c* D be 20 Chains, 50 Links; and the Side *ac* or *b* D, 10 Chains, 0 Links: Multiply *ab* 20 Chains, 50 Links, by *ac* 10 Chains, 0 Links, *facit* 20|50000; from which cutting off the laſt Figures, remains 20 Acres. Then if you multiply the Figures cut off, *viz.* 50000 by 4, *facit* 200000; from which cutting off five Figures, remains 2 Roods; and if any thing but 000 had been left, you muſt have multiplied again by 40; and then cutting off again five Figures, you would have had the odd Perches: See it done hereunder.

I need not have multiplied 00 by 40; for I know 40 times Nothing is nothing; but only to ſhew you in what Order the Figures will ſtand when you have odd Perches, as preſently we ſhall light on. So much is the Content of the long Square B, *viz.* 20 Acres, 2 Roods, 00 Perch.

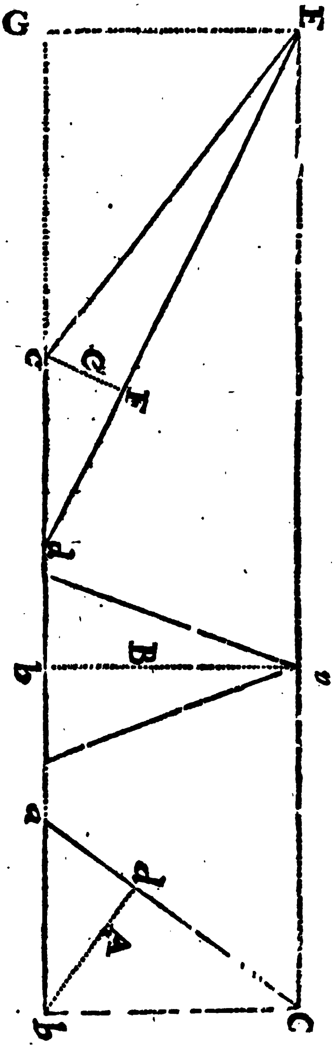
```
                  20 50
                  10.00
                ---------
Acres ——— 20|500 00
                      4
                ---------
Roods ———  2|000 00
                     40
                ---------
Perches——  0 000 00
                ---------
```

Of TRIANGLES.

The Content of all Triangles are found, by multiplying half the Baſe by the whole Perpendicular, or the whole Baſe by half the Perpendicular; or otherwiſe, by multiplying the whole Baſe and whole Perpendicular together, and taking half that Product for the Content. Either of theſe three Ways will do, take which you pleaſe.

EXAMPLE.

In the Triangle A, the Baſe *ab* is 10 Chains, 0 Links; the Perpendicular *cb*, 13 Chains, 70 Links: the half of which is 6 Chains, 85 Links; which multiplied by 10 Chains, 00 Links, *facit* 685000; from which cutting off five Figures, there is left 6 Acres. Then multiplying the Remainder by 4, *facit* 340000; from which taking five Figures, remains 3 Roods. Again, the five Figures cut off multiplied by 40, makes 1600000; from which taking five Figures, leaves 16 Perches. See the Operation.



6, 85
10,00

Acres——6|85000
4

Roods——3|40000
40

Perches——16|00000

So likewiſe in the Triangle B, the Perpendicular *a b* is 13 Chains, 70 Links; which multiplied by half the Baſe, will give the ſame Content.

Alſo in the Triangle C, if you multiply half the Baſe E *d* by the Perpendicular *c* F, the Product will be the Content of the Triangle.

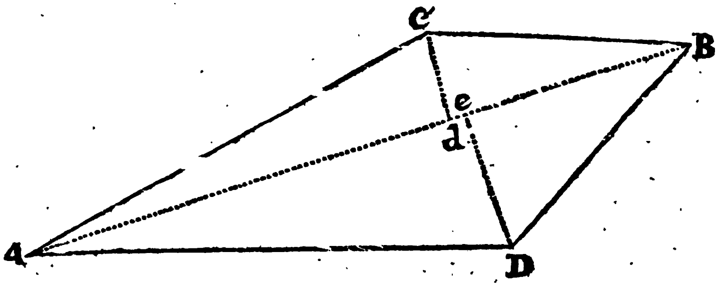
And here note, that you are not confined to any Angle; but you may let fall your Perpendicular from what Angle you pleaſe, taking the Line on which it falls for the Baſe. Thus in the Triangle A, if from *b* you let fall a Perpendicular, take *b d*, and the half of *a c* for finding the Content. Alſo in the Triangle C, you may from E let fall your Perpendicular, altho' it falls without the Triangle; and the half of E G, and the whole of *c d*, ſhall be the true Content of the Triangle C; but then you muſt remember to extend the Baſe-line *c d*.

Remember this: All Triangles having equal Baſes, and lying between parallel Lines, are of the ſame Content; ſo the Triangles A B C having equal Baſes, and lying between the Lines E C and G *b*, are therefore of the ſame Content.

To find the Content of a Trapezia.

Draw between two oppoſite Angles a ſtrait Line, as A B; then is the Trapezia reduced into two Triangles, *viz.* ABC and ABD, which you may meaſure as before taught, and adding their Products together, you will have the true Content of the Trapezia. Or a little ſhorter, thus:

Take the Length of the Line A B, which let be 37 Chains, 0 Links; take alſo the Length of the



Perpendicular D *e*, which let be 7 Chains, 40 Links; alſo C *d*, 4 Chains, 80 Links; add the two Perpendiculars together, and they make 12 Chains, 20 Links; which multiply by half the common Baſe A B, 18 Chains, 50 Links, and the Product is 22 Acres, 2 Roods, 11 Perches, as appears by the Operation hereunder.

Half the common Baſe A B 18,50
The Sum of the two Perpendiculars 12,20

37000
3700
1850

Acres — 22|57000
4

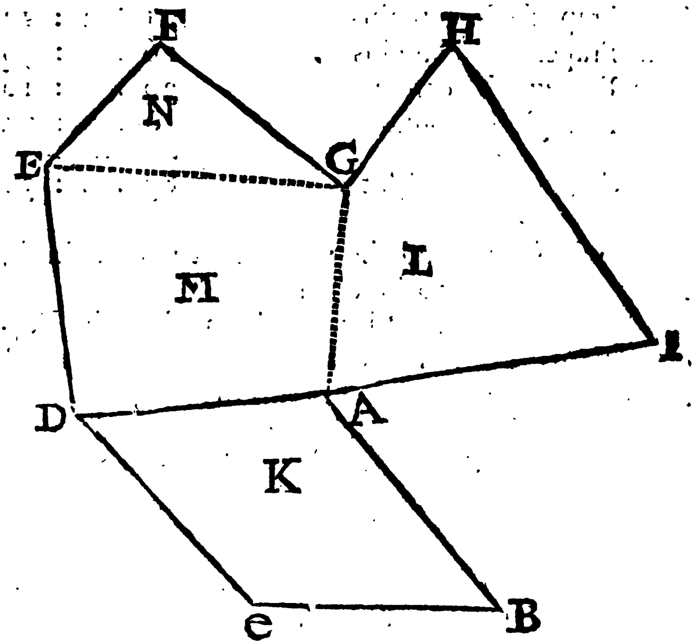
Roods— 2|28000
40

Perches—11|20000

How

How to find the Content of an irregular Plot, conſiſting of many Sides and Angles.

To do this, you muſt firſt, by drawing Lines from Angle to Angle, reduce all the Plot into Trapezia's and Triangles; after which meaſure every Trapezia and Triangle ſeverally, and adding their Contents all together, you will have the true Content of the whole Plot.



In the annexed Figure A B C D E F G H I, draw the Line A D, which cuts off the Trapezia K; alſo the Line A G, which cuts off the Trapezia L. And laſtly, the Line G E, which makes the Trapezia M, and the Triangle N, ſo is the whole Plot reduced into the three Trapezia's K, L, M, and the Triangle N: All which I meaſure as before taught, and put them down as hereunder.

	Acres.	Roods.	Perches.
The Trapezia K contains	21	2	12
The Trapezia L contains	26	3	18
The Trapezia M contains	30	2	16
The Triangle N contains	6	2	24
The Content of the Plot	85	2	30

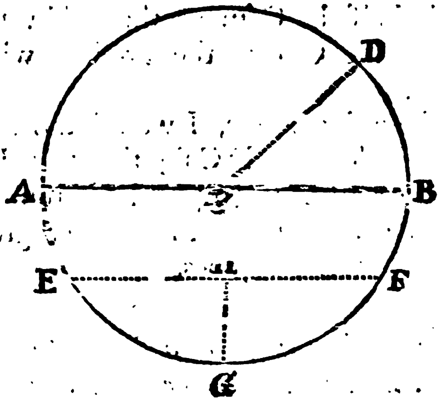
By which you find the whole Plot to contain 85 Acres, 2 Roods, 30 Perches.

If the Sides of the Plot had been given in Perches, Yards, Feet, or any other Meaſure, you muſt ſtill caſt up the Content after this manner, and then your Product will be Perches, Yards, &c. To turn which into Acres, Roods, and Perches, I have largely treated of in the Beginning of this Book.

How to find the Content of a Circle, or any Portion thereof.

To find the Content of the whole Circle, it is convenient, that firſt you know the Diameter and Circumference thereof; one of which being known, the other is eaſily found; for as 7 is to 22, ſo is the Diameter to the Circumference; and as 22 is to 7, ſo is the Circumference to the Diameter.

In this annexed Figure, the Diameter A B is 2 Chains, or 200 Links; which multiplied by 22,



and the Product divided by 7, gives 6 Chains, 28 Links, and ſomething more for the Circumference. Now, to know the ſuperficial Content, multiply half the Circumference by half the Diameter, the Product will be the Content: Half the Circumference is 3 Chains, 14 Links; half the Diameter, 1 Chain, 0 Links: which multiplied together, the Product is 3,1400 ſquare Links, or 1 Rood, 10 Perches, the Content of the Circle. Again;

By the Diameter only to find the Content.

As 14 is to 11, ſo is the Square of the Diameter to the Content. The Square of the Diameter is

40000, which multiplied by 11, makes 440000; which divided by 14, gives 31428, or 1 Rood, 14 Perches, and ſomething more for the Content.

How to meaſure the ſuperficial Content of the Section of a Circle.

Multiply half the Compaſs thereof by the Semidiameter of the Circle, the Product will anſwer your Deſire.

In the foregoing Circle, I would know the Content of that little Piece D C B; the Arch D B is 78 Links ½; the half of it 39¼; which multiplied by 1 Chain, 0 Links, the Semidiameter gives 3925 ſquare Links, or 6 $\frac{2}{4}$ Perches.

How to find the Content of a Segment of a Circle without knowing the Diameter.

Let E F G be the Segment, the Chord E F is 1 Chain, 70 Links, or 170 Links, the Perpendicular G H 50 Links; now multiply ⅔ of the one by the whole of the other, the Product will be the Content; the two Thirds of 170 is the neareſt 113, which multiplied by 50, produces 5650 ſquare Links, or 9 Perches.

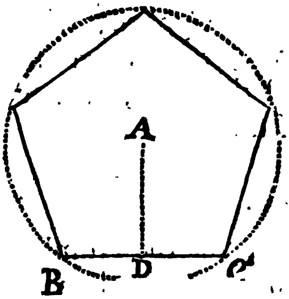
How to find the ſuperficial Content of an Oval.

The common Way is to multiply the long Diameter by the ſhorter, and obſerve the Product; and then, as if you were meaſuring a Circle, ſay, As 14 to 11, ſo the ſaid Product to the Content of the Oval; but this is not exact. A better Way is,

As 1,$\frac{27}{100}$ is to the Length of the Oval, ſo is the Breadth to the Content; or nearer, as 1,27324 to the Length, ſo the Breadth to the Content.

How to find the ſuperficial Content of Regular Polygons; as Pentagons, Hexagons, Heptagons, &c.

Multiply half the Sum of the Sides by a Perpendicular let fall from the Centre upon one of the Sides, the Product will be the Area or ſuperficial Content of the Polygon. In the following Pentagon the Side B C is 84 Links, the whole Sum of the five Sides therefore muſt be 420, the half of which is 210; which multiplied by the Perpendicular AD 56 Links gives 11760 ſquare Links for the Content, or 18 Perches $\frac{8}{10}$ of a Perch, almoſt 19 Perches.



I have been ſhorter about theſe three laſt Figures than my uſual Method, becauſe they very rarely fall into the Surveyor's way to meaſure them in Land, though indeed in broad Meaſure, Paving, &c. often.

CHAP. VIII.

Of laying out new Lands; very uſeful for Surveyors, in his Majeſty's Plantations in America.

A certain Quantity of Acres being given, how to lay out the ſame in a ſquare Figure.

ANNEX to the Number of Acres given 5 Cyphers, which will turn the Acres into Links; then from the Number thus increaſed extract the Root, which ſhall be the Side of the propoſed Square.

EXAMPLE.

Suppoſe the Number given be 100 Acres, which I am to lay out in a ſquare Figure; I join to the 100 5 Cyphers, and then it is 100,00000 ſquare Links; the Root of which is 3162 neareſt, or 31 Chains, 62 Links, the Length of one Side of the Square.

Again:

If I were to cut out of a Corn-Field one ſquare Acre, I add to 1 five Cyphers, and then is it 100000; the Root of which is 3 Chains, 16 Links, and ſomething more for the Side of that Acre.

How

How to lay out any given Quantity of Acres in a Parallelogram, whereof one Side is given.

Turn firſt the Acres into Links, by adding, as before, five Cyphers; that Number thus increaſed divide by the given Side, the Quotient will be the other Side.

EXAMPLE.

It is required to lay out 100 Acres in a Parallelogram, one Side of which ſhall be 20 Chains, 0 Links; firſt to the 100 Acres I add five Cyphers, and it is 100,00000; which I divide by 20 Chains, 0 Links; the Quotient is 50 Chains, 0 Links, for the other Side of the Parallelogram.

How to lay out a Parallelogram that ſhall be 4, 5, 6, *or* 7, &c. *times longer than it is broad.*

In *Carolina*, all Lands lying by the Sides of Rivers, except Seigniories or Baronies, are (or ought, by Order of the Lords Proprietors to be) thus laid out. To do which, firſt, as above taught, turn the given Quantity of Acres into Links, by annexing five Cyphers; which Sum divide by the Number given for the Proportion between the Length and Breadth, as 4, 5, 6, 7, *&c.* the Root of the Quotient will ſhew the ſhorteſt Side of ſuch a Parallelogram.

EXAMPLE.

Admit it were required of me to lay out 100 Acres in a Parallelogram, that ſhould be five times as long as broad: Firſt, to the 100 Acres I add five Cyphers, and it makes 100,00000; which Sum I divide by 5, the Quotient is 2000000; the Root of which is neareſt 14 Chains, 14 Links; and that, I ſay, ſhall be the ſhort Side of ſuch a Parallelogram; and by multiplying that 1414 by 5, ſhews me the longeſt Side thereof to be 70 Chains, 70 Links.

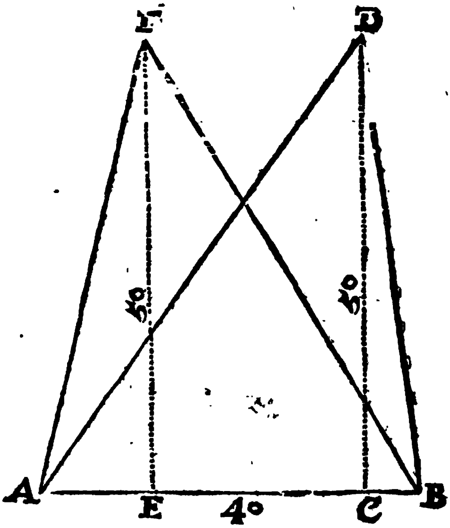
How to make a Triangle that ſhall contain any Number of Acres, being confined to a certain Baſe.

Double the given Number of Acres, (to which annexing firſt five Cyphers) divide by the Baſe, the Quotient will be the Length of the Perpendicular.

EXAMPLE.

Upon a Baſe given that is in Length 40 Chains, 0 Links; I am to make a Triangle that ſhall contain 100 Acres. Firſt, I double the 100 Acres, and annexing five Cyphers thereto, it makes 200,00000; which I divide by 40 Chains, 0 Links, the limited Baſe; the Quotient is 50 Chains, 0 Links, for the Height of the Perpendicular. As in this Figure, A B is the given Baſe 40; upon any Part of which Baſe I ſet the Perpendicular 50, as at C; then the Perpendicular is C D.

Therefore I draw the Lines D A, D B, which makes the Triangle D A B to contain juſt 100 Acres, as required. Or if I had ſet the Perpendicular at E, then would E F have been the Perpendicular 50; and by drawing the Lines FA, F B, I ſhould have made the Triangle F A B, containing 100 Acres, the ſame as D A B.



If you conſider this well when you are laying out a new Piece of Land, of any given Content, in *America*, or elſewhere, although you meet in your way with 100 Lines and Angles; yet you may, by making a Triangle to the firſt Station you began at, cut off any Quantity required.

How to find the Length of the Diameter of a Circle, which ſhall contain any Number of Acres required.

Say, As 11 is to 14, ſo will the Number of Acres given be to the Square of the Diameter of the Circle required.

EXAMPLE.

What is the Length of the Diameter of a Circle, whoſe ſuperficial Content ſhall be 100 Acres? Add five Cyphers to the 100, and it makes 100,00000 Links; which multiply by 14, *facit* 140000000; which divided by 11, gives for Quotient 12727272; the Root of which is 35 Chains, 67 Links, and better, almoſt 68 Links: And ſo much ſhall be the Diameter of the required Circle.

I might add many more Examples of this Nature; as how to make Ovals, Regular Polygons, and the like, that ſhould contain any aſſigned Quantity of Land. But becauſe ſuch things are merely for Speculation, and ſeldom or never come in Practice, I at preſent omit them.

CHAP.

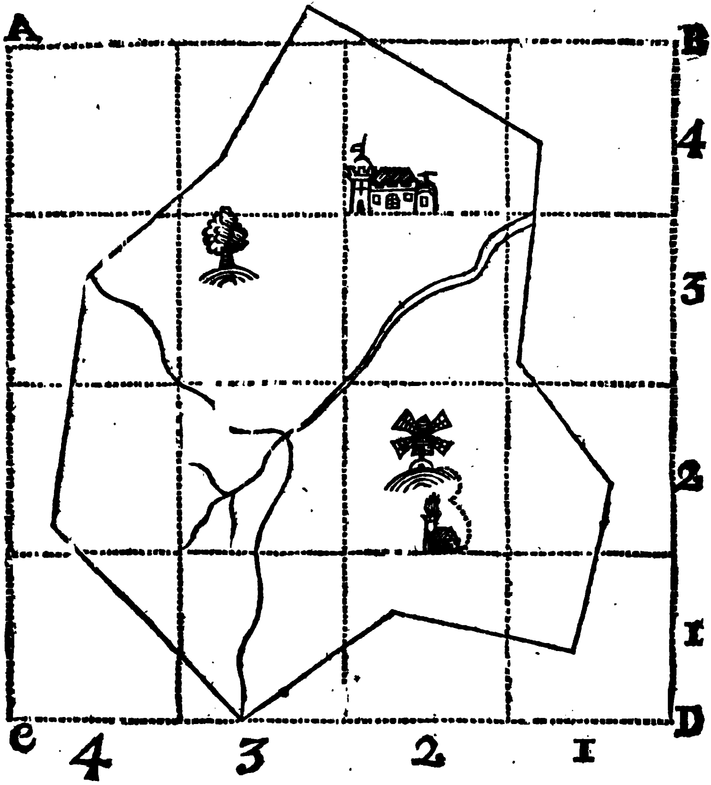
CHAP. IX.

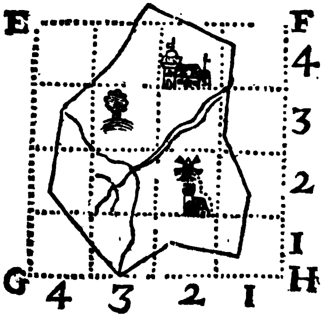
Of REDUCTION.

How to reduce a large Plot of Land or Map into a leſſer Compaſs, according to any given Proportion; or, è contra, *how to enlarge one.*

THE beſt Way to do this, is, if your Plot be not over-large, to plat it over again by a ſmaller Scale: But if it be large, as the Map of a County, or the like, the only Way is to compaſs in the Plot firſt with one great Square; and afterwards to divide that into as many little Squares as you ſhall ſee convenient. Alſo make the ſame Number of little Squares upon a fair Piece of Paper by a leſſer Scale, according to the Proportion given. This done, ſee in what Square, and Part of the ſame Square, any remarkable Accident falls, and accordingly put it down in your leſſer Squares; and that you may not miſtake, it is a good Way to number your Squares. I cannot make it plainer, than by giving you the following Example, where the Plot A B C D, made by a Scale of 10 Chains in an Inch, is reduced into the Plot E F G H, of 30 Chains in an Inch.

There


A
B
4
3
2
I
D
e
4
3
2
I


E
F
4
3
2
I
H
G
4
3
2
I

There are ſeveral other Ways taught by Surveyors for reducing Plots or Maps, as Mr. *Rathborn*, and after him Mr. *Holwell*, adviſeth to make uſe of a Scale or Ruler; having a Centre Hole at one End, through which to faſten it down on a Table, ſo that it may play freely round, and numbred from the Centre-end to the other with Lines of equal Parts. The Uſe of which is thus: Lay down upon a ſmooth Table the Map or Plot that you would reduce, and glew it with Mouth-glew faſt to the Table at the four Corners thereof. Then taking a fair piece of Paper, about the Bigneſs that you would have your reduced Plot to be of, and lay that down upon the other; the middle of the laſt about the middle of the firſt. This done, lay the Centre of your Reducing-Scale near the Centre of the white Paper, and there with a Needle through the Centre make it faſt; yet ſo, that it may play eaſily round the Needle. Then moving your Scale to any remarkable thing of the firſt Plot, as an Angle, a Houſe, the Bent of a River, or the like; ſee againſt how many equal Parts of the Scale it ſtands, as ſuppoſe 100; then taking the ½, the ¼, the ⅓, or any other Number thereof, according to the Proportion you would have the reduced Plot to bear, and make a Mark upon the white Paper againſt 50, 25, 33, &c. of the ſame Scale: And thus turning the Scale about, you may firſt reduce all the outermoſt Parts of the Plot. Which done, you muſt double the leſſer Plot, firſt ½ thereof, and then the other; by which you may ſee to reduce the innermoſt Part near the Centre.

But I adviſe rather to have a long Scale, made with the Centre-hole for fixing it to the Table, in about one third Part of the Scale, ſo that $\frac{2}{3}$ of the Scale may be one way number'd with equal Parts from the Centre-hole to the End; and $\frac{1}{3}$ Part thereof number'd the other way to the End with the ſame Number of equal Parts, tho' leſſer. Upon this Scale may be ſeveral Lines of equal Parts, the leſſer to the greater, according to ſeveral Proportions. Being thus provided with a Scale, glew down upon a ſmooth Table your greater Plot to be reduced; and cloſe to it, upon the ſame Table, a Paper, about the Bigneſs whereof you would have your ſmaller Plot. Fix with a ſtrong Needle the Centre of your Scale between both; then turning the longer End of your Scale to any remarkable thing of your Plot; to be reduced, ſee what Number of equal Parts it cuts, as ſuppoſe 100; there holding faſt the Scale, againſt 100 upon the ſmaller End of your Scale make a Mark upon the white Paper: So do round all the Plot, drawing Lines, and putting down all other Accidents as you proceed, for fear of Confuſion through many Marks in the end; and when you have done, although at firſt the reduced Plot will ſeem to be quite contrary to the other, yet when you have unglewed it from the Table, and turned it about, you will find it to be an exact Epitome of the firſt. You may have for this Work divers Centres made in one Scale, with equal Parts proceeding from them accordingly; or you may have divers Scales, according to ſeveral Proportions; which is better.

What has been hitherto ſaid concerning the Reducing of a Plot from a greater Volume to a leſſer, the ſame is to be underſtood, *vice verſa*, of enlarging a Plot from a leſſer to a greater. But this laſt ſeldom comes in practice.

How

How to change Cuſtomary Meaſure into Statute, and the contrary.

In ſome Parts of *England*, for Wood-Lands; and in moſt Parts of *Ireland*, for all Sorts of Lands; they account 18 Foot to a Perch, and 160 ſuch Perches to make an Acre, which is called *Cuſtomary Meaſure*. Whereas our true Meaſure for Land, by *Act of Parliament*, is but 160 Perches for one Acre, at 16 Foot $\frac{1}{2}$ to the Perch. Therefore to reduce the one into the other, the Rule is,

As the Square of one Sort of Meaſure,
is to the Square of the other:
So is the Content of the one,
to the Content of the other.

Thus, if a Field meaſured by a Perch of 18 Feet, accounting 160 Perches to the Acre, contain 100 Acres; How many Acres ſhall the ſame Field contain by a Perch of 16 Feet $\frac{1}{2}$?

Say, If the Square of 16 Feet $\frac{1}{2}$, *viz.* 272.25, give the Square of 18 Feet, *viz.* 324, What ſhall 100 Acres *Cuſtomary* give? Anſwer, 119 $\frac{9}{10}$ of an Acre *Statute.*

Knowing the Content of a Piece of Land, to find out what Scale it was plotted by.

Firſt, By any Scale meaſure the Content of the Plot; which done, argue thus:

As the Content found, is to the Square of the
Scale I tried by;
So is the true Content, to the Square of the true
Scale it was plotted by.

Admit there is a Plot of a piece of Land containing 10 Acres, and I meaſuring it by the Scale 11 in an Inch, find it to contain 12 Acres $\frac{1}{10}$ of an Acre; then I ſay, If 12 $\frac{1}{10}$ give for its Scale 11, What ſhall 100 give? Anſwer, 10. Therefore I conclude that Plot to be made by a Scale of 10 in the Inch. And ſo much concerning Reducing Lands.

CHAP. X.

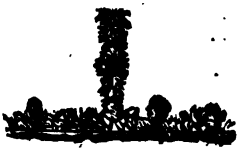
Inſtructions for ſurveying a Manor, County, or whole Country.

To ſurvey a Manor, obſerve theſe following RULES.

1. WALK or ride over the Manor once or twice, that you may have as it were a Map of it in your Head; by which means you may the better know where to begin, and proceed on with your Work.

2. If you can conveniently run round the whole Manor with your Chain and Inſtrument, taking all the Angles, and meaſuring all the Lines thereof; taking notice of Roads, Lanes, or Commons, as you croſs them: Alſo minding well the Ends of

all dividing Hedges, where they but upon your Bound-Hedges, in this manner.



3. Take a true Draught of all the Roads and By-Lanes in the Manor, putting down alſo the true Buttings of all the Field-Fences to the Road. If the Road be broad, or goes through ſome Common or waſte Ground, the beſt Way is to meaſure, and take the Angles on both Sides thereof; but if it be a narrow Lane, you may only meaſure along the midſt thereof, taking the Angles and Off-ſets to the Hedges, and meaſure your Diſtances truly: Alſo if there be any conſiderable River either bounds or runs through the Manor, ſurvey that alſo truly, as is hereafter taught.

4. Make a true Plot upon Paper of all the foregoing Work; and then will you have a Reſemblance of the Manor, though not compleat; which to make ſo, go to all the Buttings of the Hedges, and there ſurvey every Field diſtinctly, plotting it accordingly every Night, or rather twice a Day, till you have perfected the whole Manor.

5. When thus you have plotted all the Fields, according to the Buttings of the Hedges found in your firſt Surveys, you will find that you have very nigh, if not quite, done the whole Work: But if there be any Fields lie ſo within others, that they are not bounded on either Side by a Road, Lane, nor River; then you muſt alſo ſurvey them, and place them in your Plot, accordingly as they are bounded by other Fields.

6. Draw a fair Draught of the whole, putting down therein the Manor-Houſe, and every other conſiderable Houſe, Wind-mill, Water-mill, Bridge, Wood, Coppice, Croſs-paths, Rills, Runs of Water, Ponds, and any other Matters notable therein. Alſo in the fair Draught, let the Arms of the Lord of the Manor be fairly drawn, and a Compaſs in ſome waſte part of the Paper; alſo a Scale, the ſame by which it was plotted: You muſt alſo beautify ſuch a Draught with Colours and Cuts, according as you ſhall ſee convenient.

Write down alſo in every Field the true Content thereof; and if it be required, the Names of the preſent Poſſeſſors, and their Tenures, by which they hold it of the Lord of the Manor.

The Quality alſo of the Land you may take notice of as you paſs over it, if you have Judgment therein, and it be required of you.

How to take the Draught of a County or Country.

1. If the County or Country is in any Place thereof bounded with the Sea, ſurvey firſt the Sea-coaſt thereof, meaſuring it all along with the Chain, and taking all the Angles thereof truly:

2. Which done, and plotted by a large Scale, ſurvey next all Rocks, Sands, or other Obſtacles that lie at the Entrance of every River, Harbour, Bay or Road upon the Coaſt of that County or Country; which plot down accordingly, as I ſhall teach you in this Book by and by.

3. Survey all the Roads, taking notice as you go along of all Towns, Villages, great Houſes, Rivers, Bridges, Mills, Croſs-ways, *&c.* Alſo take the Bearing at two Stations of ſuch Remarks as you ſee out of the Road, or by the Side thereof.

4. Alſo ſurvey all the Rivers, taking notice how far they are Navigable, what (and where) the Branches run into them, what Fords they have, Bridges, *&c.*

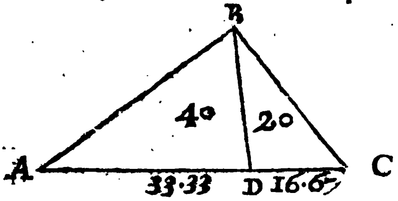
5. All this being exactly plotted, will give you a truer Map of the Country than any that I know of hath been yet made in *England.* However, you may look upon old Maps, and if you find therein any thing worth Notice that you have not yet put down, you may go and ſurvey it; and thus by degrees you may ſo finiſh a Country, that you need not ſo much as leave out one Gentleman's Houſe; for hardly will it eſcape, but ſome very remarkable thing will come into your View, either from the Roads, the Rivers, or Sea-coaſt.

6. Laſtly, With a large Quadrant take the true Latitude of the Place, in three or four Places of the County; which put down upon the Edge of your Map accordingly.

CHAP. XI.

Of Dividing LANDS.

How to divide a Triangle ſeveral Ways.

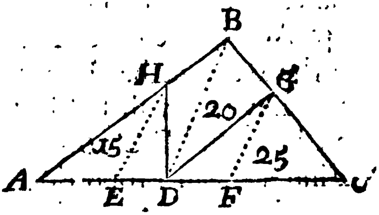


SUppoſe A B C to be a Triangular Piece of Land containing 60 Acres, to be divided between two Men, the one to have 40 Acres cut off towards A, and the other 20 Acres towards C; and the Line of Diviſion to proceed from the Angle B. Firſt meaſure the Baſe A C, *viz.* 50 Chains, 0 Links; then ſay by the Rule of Three, If the whole Content 60 Acres give 50 Chains for its Baſe, what ſhall 40 Acres give? Multiply and divide, the Quotient ſhall be 33 Chains, 33 Links; which ſet off upon the Baſe from A to D, and draw the Line B D, which ſhall divide the Triangle as was required. If it had been required to have divided the ſame into 3, 4, 5, or more unequal Parts, you muſt in the like manner, by the Rule of Three, have found the Length of each ſeveral Baſe; much after the ſame manner as Merchants put their Gains by the Rule of Fellowſhip.

There are ſeveral Ways of doing this by Geometry without the help of Arithmetick; but my Buſineſs is not to ſhew you what may be done, but to ſhew you how to do it the moſt eaſy and practicable Way.

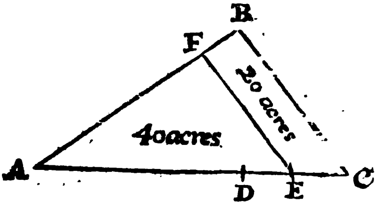
How to divide a Triangular Piece of Land into any Number of Equal and Unequal Parts, by Lines proceeding from any Point aſſigned in any Side thereof.

Let A B C the Triangular Piece of Land, containing 60 Acres, to be divided between three Men, the firſt to have 15 Acres, the ſecond 20, and the third 25 Acres, and the Lines of Diviſion to proceed from D: Firſt meaſure the Baſe, which is 50 Chains; then divide the Baſe into three Parts, as you have been before taught, by ſaying, If 60 give 50; what ſhall 15 give? Anſwer, 12 Chains, 50 Links for the firſt Man's Baſe; which ſet off from A to E. Again, ſay, If 60 give 50, what ſhall 20 give? Anſwer, 16 Chains, 66 Links for the ſecond Man's Baſe; which ſet off from E to F, then conſequently the third Man's Baſe, *viz.* from F to C, muſt be 20 Chains, 84 Links. This done, draw an obſcure Line from the Point aſſigned D, to the oppoſite Angle B, and from E and F draw the Lines E A and F G parallel to B D. Laſtly, From D draw the Lines D H, D G, which ſhall divide the Triangle into three ſuch Parts as was required.



How to divide a Triangular Piece of Land, according to any Proportion given by a Line parallel to one of the Sides.

ABC is the Triangular Piece of Land, containing 60 Acres, the Baſe AC is 50 Chains: This Piece of Land is to be divided between two Men, by a Line parallel to BC, in ſuch Proportion that the one have 40 Acres, the other 20.



Firſt divide the Baſe, as has been before taught, and the Point of Diviſion will fall in D, AD being 33 Chains, 33 Links; and DC 16 Chains, 67 Links.

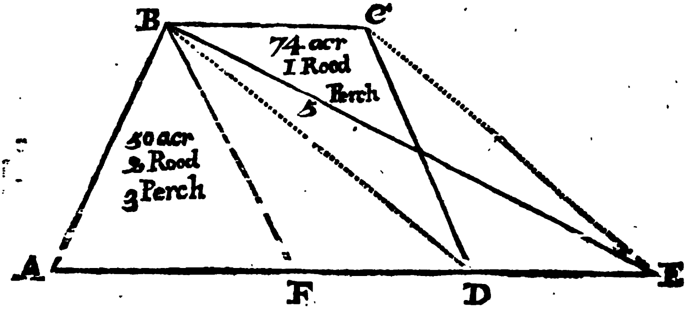
Secondly, Find a mean Proportion between AD and AC; by multiplying the whole Baſe 50 by AD 33, 33, the Product is 1666 5000; of which Sum extract the Root, which is 40 Chains, 82 Links; which ſet off from A to E. Laſtly, From E draw a Line parallel to BC, as is the Line EF; which divides the Triangle as demanded.

Of dividing Four-ſided Figures or Trapezia's.

Before I begin to teach you how to divide Pieces of Land of four Sides, it is convenient firſt to ſhew you how to change any Four-ſided Figure into to a Triangle; which done, the Work will be the ſame as in dividing Triangles.

How to reduce a Trapezia into a Triangle, by Lines drawn from any Angle thereof.

Let A B C D be the Trapezia to be reduced into a Triangle, and B the Angle aſſigned: Draw the dark Line B D, and from C make a Line parallel thereto, as C E; extend alſo the Baſe A D, till it meet C E in E; then draw the Line B E, which ſhall make the Triangle B A E equal to the Trapezia A B C D.



Now to divide this Trapezia according to any aſſigned Proportion, is no more but to divide the Triangle A B E, as before taught; which will alſo divide the Trapezia.

EXAMPLE.

Suppoſe the Trapezia A B C D, containing 124 Acres, 3 Roods, and 8 Perches, is to be divided between two Men, the firſt to have 50 Acres, 2 Roods, and 3 Perches; the other 74 Acres, 1 Rood, and 5 Perches, and the Line of Diviſion to proceed from B.

Firſt, Reduce all Acres and Roods into Perches, then will the Content of the Trapezia be 19968 Perches; the firſt Man's Share 8083 Perches, the ſecond 11885.

Secondly, Meaſure the Baſe of the Triangle, *viz.* AE 78 Chains, 00 Links:

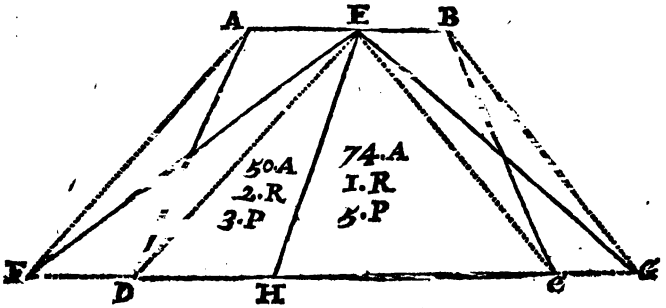
Then ſay, If 19968 the whole Content give for its Baſe } 78 Chains, 00 Links,

What ſhall 8083, the firſt Man's Part, give? Anſwer } 31 Chains, 52 Links:

Which ſet off from A to F, and drawing the Line F B, you divide the Trapezia as deſired; the Triangle A B F being the Firſt Man's Portion, and the Trapezia B C F D the Second's.

How to reduce a Trapezia into a Triangle, by Lines drawn from a Point aſſigned in any Side thereof.

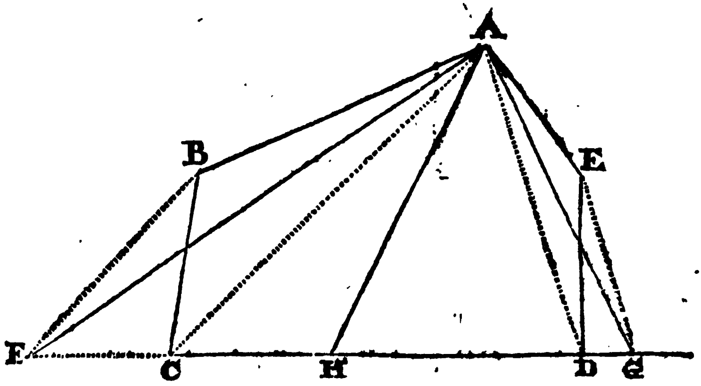
A B C D the Trapezia, E the Point aſſigned, from whence to reduce it into a Triangle, and run the Diviſion Line; the Trapezia is of the ſame Con-



tent as the former, *viz.* 19968 Perches; and it is to be divided as before, *viz.* one Man to have 8083 Perches, and the other 11885. Firſt, for to reduce it into a Triangle, draw the Lines E D, E C, and from A and B make Lines parallel to them, as A F, B G; then draw the Lines E G, E F, and the Triangle E F G will be equal to the Trapezia A B C D, which is divided as before; for when you have found by the Rule of Proportion, what the firſt Man's Baſe muſt be, *viz.* 31 Chains, 52 Links, ſet it from F to H, and draw the Line H E, which ſhall divide the Trapezia according to the former Proportion.

How to reduce an irregular Five-ſided Figure into a Triangle, and to divide the ſame.

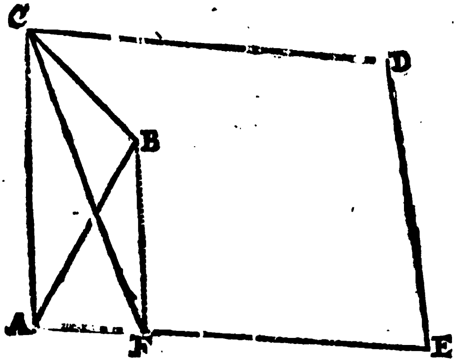
Let A B C D E be the Five-ſided Figure; to reduce which into a Triangle, draw the Lines A C,



A D; and parallel thereto B F, E G, extending the Baſe from C to F, and from D to G; then draw the Lines A F, A G, which will make the Triangle A F G equal to the Five-ſided Figure. If this was to be divided into two equal Parts, take the half of the Baſe of the Triangle, which is F H, and from H draw the Line H A; which divides the Figure A B C D E into two equal Parts. The like you may do for any other Proportion.

If in dividing the Plot of a Field there be outward Angles, you may change them after the following manner.

Suppoſe A B C D E be the Plot of a Field; and B the outward Angle.

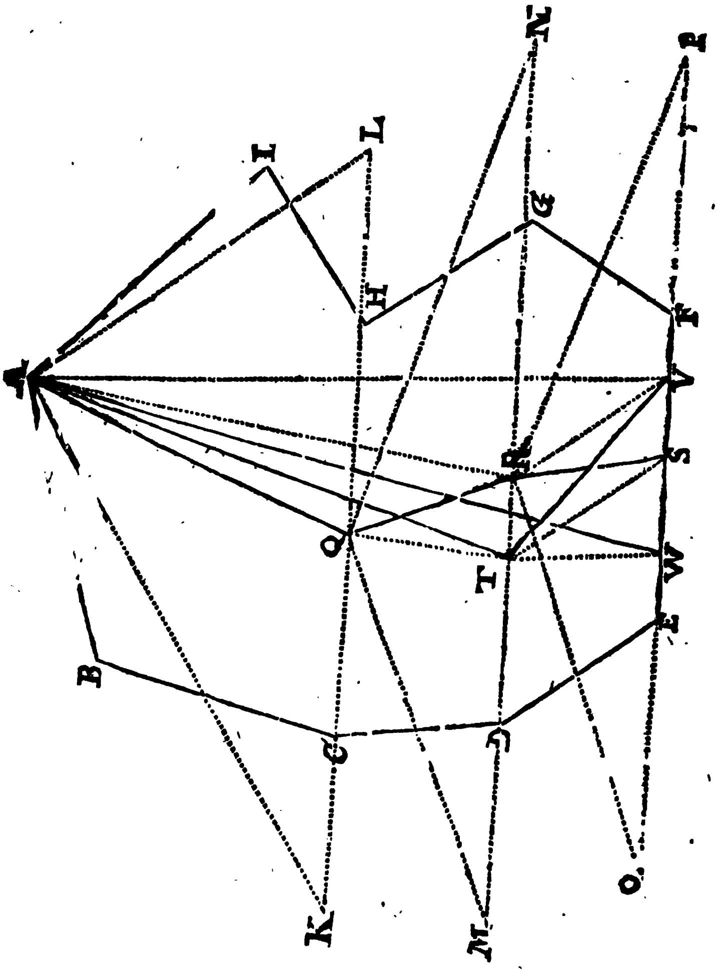


Draw the Line C A, and parallel thereunto the Line B F.

Laſtly, The Line C F ſhall be of as much Force as the Lines C B and B A. So is that Five-ſided Figure, having one outward Angle reduced into a Four-ſided Figure, or Trapezia; which you may again reduce into a Triangle, as has been before taught.

How

How to divide an Irregular Plot of any Number of Sides, according to any given Proportion, by a ſtrait Line through it.



A B C D E F G H I is a Field to be divided between two Men in equal Halfs, by a ſtrait Line proceeding from A.

Firſt, Conſider how to divide the Field into Five-ſided Figures and Trapezia's, that you may the better reduce it into Triangles: As by drawing the Line K L, you cut off the Five-ſided Figure A B C H I; which reduce into the Triangle A K L, and meaſuring half the Baſe thereof, which will fall at Q, draw the Line Q A.

Secondly, Draw the Line M N, and from the Point Q reduce the Trapezia C D G H into the Triangle M N Q; which again divide into Halfs, and draw the Line Q R.

Thirdly, From the Point R reduce the Trapezia D E F G into the Triangle R O P; and taking half the Baſe thereof, draw the Line R S; and then have you divided this irregular Figure into two equal Parts by the three Lines A Q, Q R, R S.

Fourthly, Draw the Line AR, alſo Q T parallel thereto. Draw alſo AT, and then have you turned two of the Lines into one.

Fifthly, From T draw the Line T S, and parallel thereto the Line R V: Draw alſo T V. Then is your Figure divided into two equal Parts by the two Lines AT and T V.

Laſtly, Draw the Line A V, and parallel thereto TW. Draw alſo AW, which will cut the Figure into two equal Parts by a ſtrait Line, as was required.

You may, if you pleaſe, divide ſuch a Figure all into Triangles; and then divide each Triangle from the Point where the Diviſion of the laſt fell, and then will your Figure be divided by a crooked Line, which you may bring into a ſtrait one, as above.

This above is a good Way of dividing Lands; but Surveyors ſeldom take ſo much pains about it. I ſhall therefore ſhew you how commonly they abbreviate their Work, and is indeed

An eaſy Way of dividing Lands.

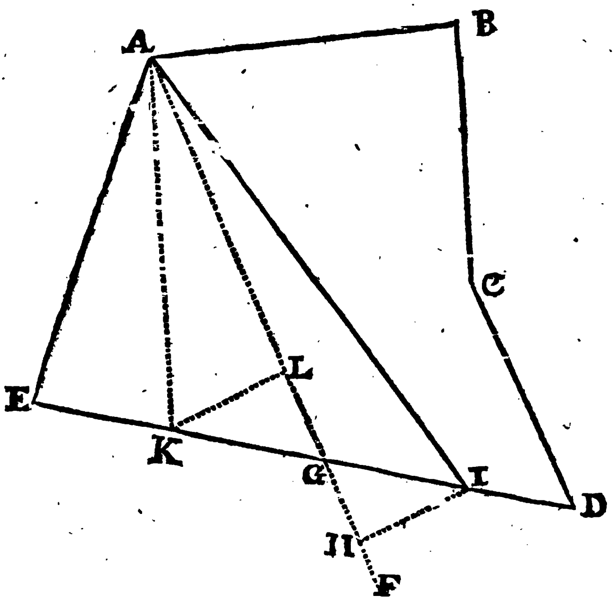
Admit the following Figure A B C D E contain 46 Acres, to be divided into Halfs between two Men, by a Line proceeding from A.

Draw firſt a Line by gueſs, through the Figure, as the Line A F. Then caſt up the Content of either Half, and ſee what it wants, or what it is more than the true Half ſhould be.

As for Example: I caſt up the Content of AEG, and find it to be but 15 Acres; whereas the true Half is 23 Acres; 8 Acres being in the Part A B C D G more than A E G. Therefore I make a Triangle containing 8 Acres, and add it to A E G, as the Triangle A G I; then the Line A I puts the Figure into equal Halfs.

But more plainly how to make this Triangle: Meaſure firſt the Line A G, which is 23 Chains, 60 Links. Double the 8 Acres, they make 16; to which add five Cyphers to turn them into Chains and Links, and then they make 1600000; which divide by A G 2360, the Quotient is 6 Chains, 77 Links; for the Perpendicular H I, take from your Scale 6 Chains, 77 Links, and ſet it ſo from the Baſe A G F, that the End of the Perpendicular may juſt touch the Line E D, which will be at I. Then draw the Line A I, which makes the Triangle A C I juſt 8 Acres, and divides the whole Figure as deſired.

If



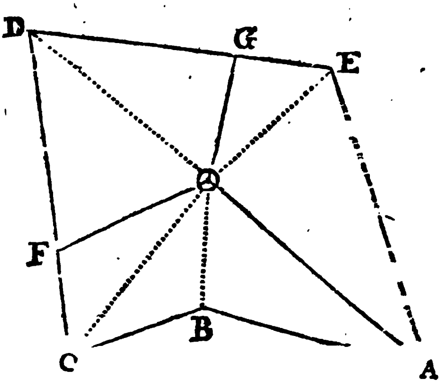
If it had been required to have ſet off the Perpendicular the other way, you muſt ſtill have made the End of it but juſt touch the Line E D, as L K does: For the Triangle A K G is equal to the Triangle A G I, each 8 Acres.

And thus you may divide any Piece of Land of ever ſo many Sides and Angles, according to any Proportion, by ſtrait Lines through it, with as much Certainty, and more Eaſe, than the former Way.

Mark, You might alſo have drawn the Line A D, and meaſured the Triangle A G D, and afterwards have divided the Baſe G D, according to Proportion, in the Point I; which I will make more plain in this following Example.

Suppoſe the following Field, containing 27 Acres, is to be divided between three Men, each to have 9 Acres, and the Lines of Diviſion to run from a Pond in the Field, ſo that every one may have the Benefit of the Water, without going over another's Land.

Firſt, From the Pond ⊙ draw Lines to every Angle, as ⊙ A, ⊙ B, ⊙ C, ⊙ D, ⊙ E; and then is



the Figure divided into five Triangles, each of which meaſure, and put the Contents down ſeverally; which Contents reduce all into Perches, ſo will the Triangle

A ⊙ B	be	674	Perches.
B ⊙ C		390	
C ⊙ D		1238	
D ⊙ E		911	
E ⊙ A		1107	

The whole Content being 4320 Perches, or 27 Acres, each Man's Proportion being 1440 Perches.

From ⊙ to any Angle draw a Line for the firſt Diviſion-line, as ⊙ A. Then conſider that the firſt Triangle A ⊙ B is but 674 Perches, and the ſecond B ⊙ C 390, both together but 1064 Perches, leſs by 376 than 1440, one Man's Portion. You muſt therefore cut off from the third Triangle C ⊙ D 376 Perches for the firſt Man's Dividing-line; which thus you may do: The Baſe D C is 18 Chains, the Content of the Triangle 1238 Perches: Say then, If 1238 Perches give Baſe 18 Chains, 00 Links; What ſhall 376 Perches give? Anſwer, 5 Chains, 45 Links; which ſet from C to F, and drawing the Line ⊙ F, you have the firſt Man's Part, *viz.* A ⊙ F.

Secondly, See what remains of the Triangle C ⊙ D, 376 being taken out, and you will find it to be 861 Perches, which is leſs by 578 than 1440. Therefore from the Triangle D ⊙ E cut off 578 Perches, and the Point of Diviſion will fall in G. Draw the Line ⊙ G, which with ⊙ A and ⊙ F divides the Figure into three equal Parts.

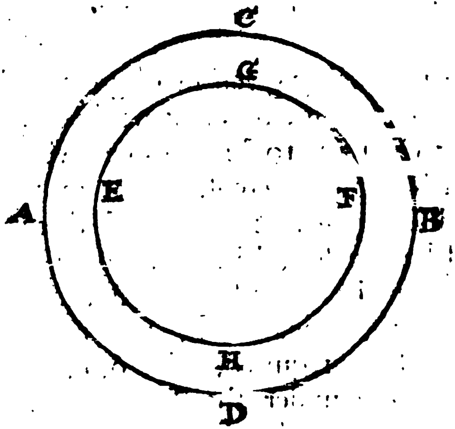
How to divide a Circle according to any Proportion, by a Line concentrick with the firſt.

All Circles are in proportion to one another as the Squares of their Diameters; therefore if you divide the Square of the Diameter or Semidiameter, and extract the Root, you will have your Deſire.

EXAMPLE.

Let A B C D be a Circle to be equally divided between two Men.

The



The Diameter thereof is 2 Chains.
The Semidiameter 1 Chain, or 100 Links.
The Square thereof 10000.
Half the Square 5000.

The Root of the Half 71 Links; which take from your Scale, and upon the ſame Centre draw the Circle G E H F, which divides the Circle A B C D into equal Parts.

CHAP. XII.

Trigonometry: *or, The Menſuration of Right-lined Triangles.*

THE Uſe of the Table of Logarithm Numbers I have ſhewed you in *Chap.* I. concerning the Extraction of the Square Root. Here follows

The

The Uſe of the Table of Sines and Tangents.

Any Angle being given in Degrees and Minutes, how to find the Sine or Tangent thereof.

Let 27 Degrees, 10 Minutes be given to find the Sine and Tangent thereof. Firſt in the Table of Sines and Tangents. at the Head thereof ſeek for 27; and having found it, look down the firſt Column on the Left-hand under M, for the 10 Minutes, and right againſt it, under the Title *Sin.* ſtands the Sine required, *viz.* 9,659517; alſo in the ſame Line under the Title *Tang.* ſtands the Tangent of 27°. 10′. *viz.* 9,710282: But if the Degrees exceed 45, then look at the Foot of the Tables for the Degrees, and upon the Right-hand Column for the Minutes; and right againſt it you will find the Sine and Tangent above the Title *Sine. Tan.* Thus, the Sine of 64 Degrees, 50 Minutes, is 9,956684; the Tangent thereof is 10,328037.

How to find the Co-ſine, or Sine-Complement; the Co-tangent, or Tangent-Complement of any given Degrees and Minutes.

The Co-ſine, or Co-tangent, is nothing more but the Sine and Tangent of the remaining Degrees and Minutes after Subtraction from 90; thus, take 25 Degrees, 10 Minutes from 90 Degrees, 00 Min. there will remain 64 Degrees, 50 Minutes; the Sine of which is, as before, 9,956684; and that is the Sine-Complement of 25 Degrees, 10 Minutes.

But the more ready Way to find the Coſine, or Co-tangent of any Number of Degrees given, is to look for the Degrees and Minutes as before taught, for Sines and Tangents; and right againſt it under Titles Co-ſine and Co-tangent; or above, if the Degrees exceed 45, you will find the Co-ſine or Co-tangent required: Thus the Co-ſine of 30 Degrees, 15 Minutes, is 9,936431; the Co-tangent of 58 Degrees, 10 Minutes, is 9,792974.

Any Sine or Tangent, Co-ſine or Co-tangent being given, to find the Degrees and Minutes belonging thereto.

This is only the Converſe of the former; for you muſt ſeek in the Tables for the Sine, &c. given, or the nigheſt that can be found thereto, and right againſt it you will find the *Minutes* and *Degrees* over-head. Let the Sine 8,742259 be given, right againſt it ſtands 3 *Degrees*, 10 *Minutes*.

Remember that Multiplication is performed with theſe Logarithm Tables by Addition; and Diviſion by Subtraction. If I were to multiply 5 by 4, firſt I look for the Logarithm of 5, which is 0,698970
The Logarithm of 4 is 0,602060

Added together, they make 1,301030

which 1,301030 I ſeek for in the Logarithm Tables; and right againſt, under Title *Num.* ſtands 20, the Product of 5 multiplied by 4.

If I were to divide 20 by 5, firſt I look for the

Logarithm of 20, which, as above, is	1,301039
The Logarithm of 5 is	0,698970
After Subtraction remains	0,602060

and the Number anſwering to that Logarithm you will find to be 4.

And thus by Addition and Subtraction the Rule of Three is performed with the Logarithms, *viz.* by adding the two laſt together, and out of their Product ſubtracting the firſt.

EXAMPLE.

If 15 give 32, what ſhall 45 give?

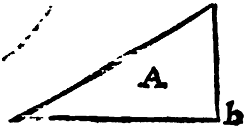
The Logarithm of 15 is	1,176091
The Logarithm of 45 is	1,653212
The Logarithm of 32 is	1,505150
The two laſt added together make	3,158362
Out of which I ſubtract the firſt, and there remains	1,982271

Againſt which 1,982271, I find the Number 96. I anſwer thereſore, If 15 gives 32, 45 ſhall give 96.

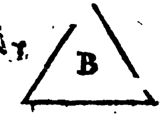
This you muſt obſerve to do in the following Caſes of Triangles, always to add the ſecond and third Numbers together, and from their Product to ſubtract the firſt, the Remainder will be the Logarithm Number, Sine, or Tangent of your required Line or Angle.

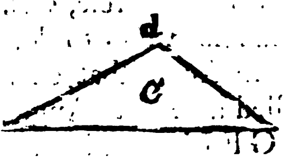
Certain Theorems for the better underſtanding Right-lined Triangles.

1. A Right-lined Triangle is a Figure comprehended within three ſtrait Lines.



2. It is either Right-angled, as A, having one right Angle, which contains juſt 90 Degrees, *viz.* that at *b*; or elſe Oblique as B, which conſiſts of three Acute Angles, neither of them ſo great as 90 Degrees; or which conſiſts of two Acute Angles and one Obtuſe, *viz.* as that D.

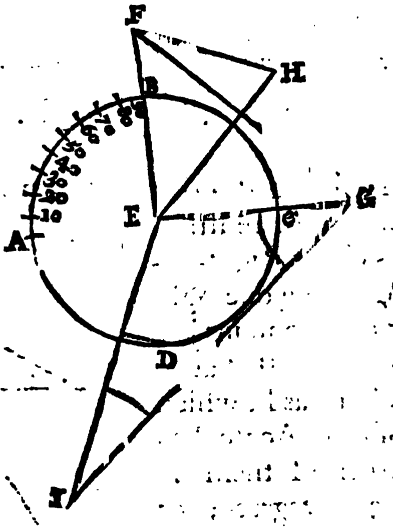




3. All the three Angles of any Triangle are equal to two Right Angles, or 180 Degrees; ſo that one Angle being known, the other two together are known alſo; or two being known, the third is alſo known by ſubtracting the two known Angles out of 180 Degrees, the Remainder is the third Angle.

To know well what the Quantity of the Angle is, take this following Demonſtration.

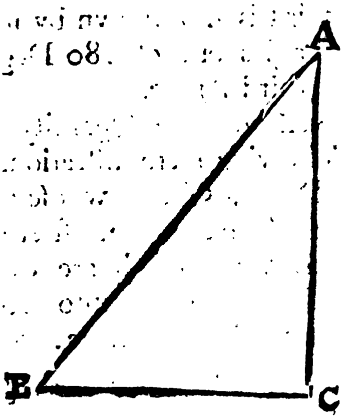
Let A B C D be a Circle, whoſe Circumference is divided (as all Circles you muſt eſteem ſo to be) into 360 equal Parts, which are called Degrees, and each of thoſe Degrees into 60 equal Parts more, which are called Minutes: Now a Right-angled Triangle is that which cuts off one fourth



Part of this Circle, *viz.* 90 Degrees, as you ſee the Triangle E F G to do.

An Angle that cuts off leſs than 90 Degrees, is called an Acute Angle, as H E F.

G E I is an Obtuſe Angle, becauſe the two Lines that proceed from E, take in between them more than a quarter of the Circle.



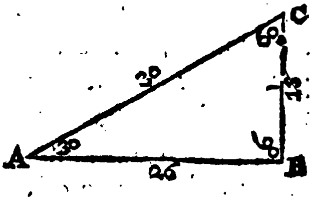
5. Every Triangle hath ſix Parts; *viz.* three Sides and three Angles; the Sides are ſometimes called Legs, but moſt commonly in Right-angled Triangles the bottom Line, as B C, is called the Baſe, A C the Perpendicular, and the longeſt Line AB is called the Hypothenuſe. The Sides are in all in Proportion to the Sines of their oppoſite Angles; ſo that any three Parts of the ſix being known, the reſt may eaſily be found.

6. When an Angle exceeds 90 Degrees, ſubtract it out of 180, and work by the Remainder.

CASE I.

In Right-angled Triangles, the Baſe being given, and the Acute Angle at the Baſe; how to find the Hypothenuſe and the Perpendicular.

In the Right-angled Triangle A B C, there is given the Baſe A B, which is 26 equal Parts, as Perches, or the like; the Angle at A is alſo given, which is 30 Degrees: Now to find the Length of the Hypothenuſe A C, ſay thus:



As the Sine Complement of the Angle at A
is to the Logarithm of the Baſe 26,
So is the Radius or the Sine of 90°
to the Logarithm of the Hypothenuſe A C 30,

The Sine Complement of 30 Degrees is	9,937531
The Logarithm of 26 is	1,414973
The Radius, or Sine of 90°	10,000000
The two laſt added together	11,414973
Remains, after ſubtracting the firſt Numb.	1,477442

Which if you look for in your Logarithm Tables, you will find the neareſt Number anſwering thereto to be 30; and ſo long is the Hypothenuſe requir'd.

Note in your Table, when you cannot find exactly the Logarithm you look for, you muſt take the neareſt thereto, as in this Example I find 1,477121 to be the neareſt to 1,477442. Mark alſo, that whereas I ſay, As the Sine Complement of the Angle at A, *&c.* you may as well ſay, As the Sine of the Angle at C is to the Log. *&c.* For the Angle at A being given in a Right-angled Triangle, you cannot be ignorant of the Angle at C. If you mind the Rule above, that all the three Angles of a Triangle are equal to two Right Angles, or 180 Degrees; for if you take the Right-angle at B 90° and that at A 30° both known, and ſubtract them out of 180°, there remains only 60° for the Angle at C. But in purſuance of our Queſtion,

How to find the Perpendicular.

As the Sine of the Angle A C B 60°
is to the Log. of the Baſe 26 A B;
So the Sine of the Angle C A B 30°
to the Log. of the Perpendicular C B 15.

Note, When I put three Letters to expreſs an Angle, the middlemoſt Letter denotes the angular Point,

The Sine 60 degr. is	9,937531
The Log. of the Baſe 26 A B is	1,414973
The Sine of 30 degr. is	9,698970
The two laſt added——	11,113943
From which ſubtract the firſt, and remains	1,176412

The neareſt Number anſwering to which is 15, which is the Length of the perpendicular Line C B.

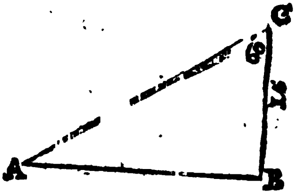
Or otherwiſe; the Hypothenuſe being firſt found, viz. A C 30 *you may find the Perpendicular thus:*

As the Sine of the Right-an. CBA or Rad.	10,000000
is to the Log. of the Hypoth. A C 30	1,477121
So is the Sine of the Angle C A B 30 deg.	9,698970
to the Log. of the Perpendicular 15	11,176091

CASE II.

The Perpendicular and Angle A C B *being given, to find the Baſe and Hypothenuſe.*

Let the Perpendicular be C B 15, as before the Angle A C B 60 deg. to find the Baſe, work thus:



As the Co-ſine of the Angle ACB
is to the Logarithm of the Perpendicular BC 15;
So is the Sine of the Angle ACB
to the Logarithm of the Baſe AB 26.

The Co-ſine of the Angle ACB 60°, is	9,698970
The Logarithm of CB 15 is	1,176091
The Sine of the Angle ACB 60, is	9,937531
	11,113622
The neareſt Log. anſwering to 26, is	1,414652

For the Hypothenuſe.

As the Sine Complement of the Angle ACB 60°
is to the Log. of the Perpendicular CB 15,
So is the Sine of the Angle ABC, or Radius 90°,
to the Log. of the Hypothenuſe 30°.

The Co-ſine of the Angle ACB is	9,698970
The Log. of the Perpend. CB 15 is	1,176091
The Radius	10,000000
The Log. of the Hypothenuſe 30	1,477121

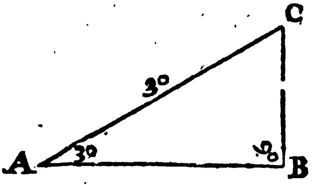
Or otherwiſe thus; the Baſe being firſt found, to find the Hypothenuſe.

As the Sine of the Angle ACB 60°	9,937531
is to the Log. of the Baſe 26	1,414973
So is Radius	10,000000
to the Log. of the Hypothenuſe (30)	1,487442

CASE

CASE III.

The Hypothenuſe, and either of the Acute Angles given, to find the Baſe and Perpendicular.



Let the Hypothenuſe be AC 30;
The Angle CAB 30.

To find the Baſe AB, *work thus:*

As the Sine of the Right Angle CBA 90°, or Radius	10,000000
is to the Log. of the Hypoth. AC 30	1,477121
So is the Co-ſine of the Angle CAB 30	9,937531
to the Log of the Baſe AB (26)	11,414652

To find the Perpendicular BC, *work thus.*

As the Sine of the Right Angle CBA 90°, or Radius	10,000000
is to the Log. of the Hypoth. AC 30	1,477121
So is the Sine of the Angle CAB 30	9,698970
to the Log. of the Perpend. (15)	11,176091

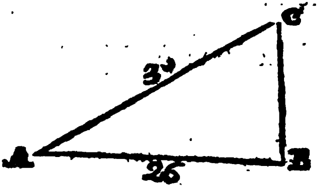
Or otherwiſe; the Baſe being found, to find the Perpendicular thus.

As the Co-ſine of the Angle C A B 30°	9,937531
is to the Log. of the Baſe A B 26	1,414973
So is the Sine of the Angle CAB (30°)	9,698970
	11,113943
to the neareſt Log. of the Perpend. (15)	1,176412

CASE IV.

The Hypothenuſe and Baſe being given, to find the two Acute Angles, viz. A C B, *and* C A B.

Let A C, the Hypothenuſe, be 30°,
A B the Baſe 26, and the Angle A C B required.



As the Logarithm of the Hypothenuſe A C 30,
is to Radius, or the Sine of the Angle C B A 90;
So is the Logarithm of the Baſe A B 26,
to the Sine of the Angle ACB 60.

The

The Operation.

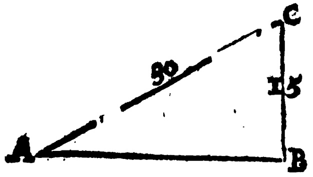
The Log. of the Hypothenuſe A C 30 is	1,477121
The Radius	10,000000
The Logarithm of the Baſe A B 26	1,414973
The Sine of ACB the Angle requir'd, 60°	9,937852

For the Angle C A B, *work thus.*

As the Log. of the Hypothenuſe A C 30	1,477121
is to the Radius 90,	10,000000
So is the Logarithm of the Baſe A B 26	1,414973
to the Co-ſine of the Angle requir'd 30	9,937852

CASE V.

The Hypothenuſe and Perpendicular being given, to find the Angles and Baſe.



The Hypothenuſal is 30.
The Perpendicular 15.
A B C a Right Angle.

Now to find the Angle at A, work thus.

As the Log. of the Hypothenuſe A C 30	1,477121
to the Radius	10,000000
So is the Log. of the Perpendicular 15 CB	1,176091
to the Sine of the Angle at A 30	9,698970

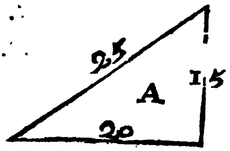
To find the Angle at C, work thus.

As the Logarithm of the Hypothenuſe A C 30
is to the Radius 90,
So is the Logarithm of the Perpendicular B C 15
to the Co-ſine of the Angle A, which is the Angle C 60.

Laſtly, To find the Baſe, work as you were taught in *Caſe* 2.

Here note, That any two Sides of a Right-angled Triangle being given, the third Side may be found by Extraction of the Square Root.

EXAMPLE.



In the Right-angled Triangle A, let the given Baſe be 20, the Perpendicular 15, and the Hypothenuſe required.

Square the Baſe 20, or multiply it by itſelf, and it makes 400: Square alſo the Perpendicular 15, and it makes 225; add the two Squares together, and they make 625; from which Sum extract the Square Root, which Root is the Length of the Hypothenusal, 25; but if the Hypothenusal and either of the other Sides be given to find the third, you must ſubtract the leſſer Square out of the greater, and the Root of the Remainder is the Side required. As for Example, the Hypothenuſe 25 is given, and the Baſe 20, to find the Perpendicular multiply the Hypothenuſe in itſelf, and it makes

200
625(25
45

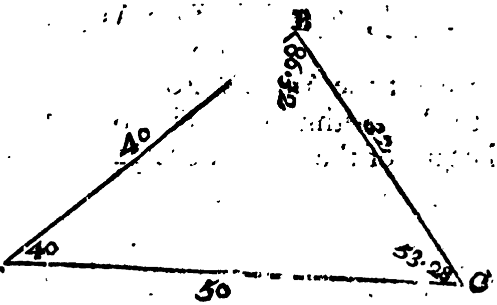
in itſelf, and it makes	625
Multiply the Baſe in itſelf, and it makes	400
Which 400 ſubtract from 625, there remains	225

The Root of which is 15, the Perpendicular requir'd.

CASE VI.

Of Oblique-angled Plain Triangles.

Two Sides of an Oblique Triangle being given, and an Angle oppoſite to either of the Sides, how to find the other two Angles and the third Side.



In the Triangle A B C there is given the Side A B 40, the Side B C 32;
The Angle at A 40 Degrees,
And the Angle at C is required.

Note, That in Oblique Triangles the ſame Rule holds good as in Right-angled Triangles, *viz.* That the Sides are in ſuch Proportion one to another, as the Sines of their oppoſite Angles.

As the Logarithm of the Side B C 32	1,505150
is to the Sine of the Angle A 40,	9,808067
~~So is~~ the Logarithm of the Side A B 40	1,602060
	11,410127
To the Sine of the Angle at C 53° :	289,904977

To find the Angle at B.

Add the two known Angles together, *viz.* that at A 40, and that at C 53.28, and they make 93 Degrees, 28 Minutes; which ſubtracted from 180 Degrees, leaves 86 Degrees, 32 Minutes, which is the Angle at B.

Laſtly, to find the Line AC, *ſay*,

As the Sine of the Angle A 40	9,808067
is to the Logarithm of the Side BC 32	1,505150
So is the Sine of the Angle 86° : 32	9.999204
	11,504354
to the Log. of the Side A C requir'd 50	1,696287

Note, Though the neareſt whole Number anſwering to the Logarithm 1696287 be 50; yet if you go to Fractions, the Length of the Line A C is but $49\frac{69}{100}$.

CASE VII.

Two Angles being given, and a Side oppoſite to one of them, to find the other oppoſite Side.

In the foregoing Triangle there is given the Angle A 40 Degrees, the Angle C 53 Degrees, 28 Minutes; alſo the Side A B 40: To find the Side B C work thus:

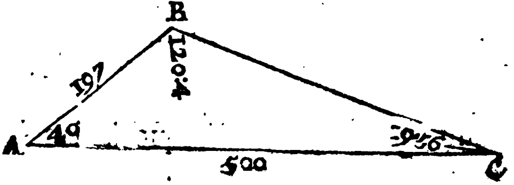
As the Sine of the Angle C 53 : 28 9,904992
is to the Logarithm of the Side A B 40 1,602060
So is the Sine of the Angle A 40 9,808067

11,410127

to the Log. of the Side B C, neareſt 32 1,505135

CASE VIII.

Two Sides of a Triangle being given, with the Angle contained by them, to find either of the other Angles.



In the Triangle A B C
there is given the Side A B 197,
The Side A C 500,
The Angle at A 40 Degrees;
Now to find either of the other Angles work thus:
As the Log. of the Sum of the 2 Sides 627 2,843233
is to the Log. of their Difference 303 2,481443
So is the Tang. of the half Sum of the two oppoſite Angles 70 Degrees } 10,438934

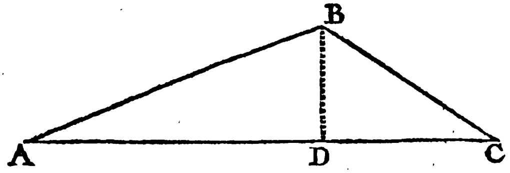
12,920377

to the Tangent of 50 degr. 4 min. 10,077144

Which 50°. 4′. added to the half Sum of the two unknown Angles, *viz.* 70°. makes 120°. 4′. which is the Quantity of the Angle at B; alſo taken from 70, leaves 19°. 56′. which is the Angle at C.

CASE IX.

Three Sides of an Oblique Triangle being given, to find the Angles.



You muſt divide your Oblique Triangle into two Right-angled Triangles thus:

In the Triangle A B C

The Side A C is	50
The Side A B	36
The Side B C	20
The Sum of the two leſſer Sides	56
The Difference of the two leſſer Sides	16

As the Log. of the greateſt Side A C 50	1,698970
is to the Logar. of the Sum of the two leſſer Sides 56	1,748188
So is the Diff. of the two leſſer Sides 16	1,204120
	2,952308
to the Log. of a fourth Number 18	1,253338

Subtract this 18 out of the greateſt Side A C 50, and there remains 32; the half of which, *viz.* 16, is the Baſe of the leſſer Right-angled Triangle, and the Remainder of the Line A C, *viz.* A D 34, is the Baſe of the greater Right-angled Triangle, into which this Oblique Triangle is divided.

And now of either Right-angled Triangle B D C, or B D A, you have the Baſe and Hypothenuſe given to find the Angles; which you muſt do as you were before taught, *Caſe* IV.

Note, That you may better and eaſier find the 4th Number, for dividing an Oblique-angled Triangle into two Right-angled Triangles by Vulgar Arithmetick, than by the Tables of Logarithms, thus:

Square the three given Sides, add the two greater Squares together, and from that Sum ſubtract the leſſer; half the Remainder divide by the greater Side, the Quotient will be the Baſe of the greater Right-angled Triangle.

EXAMPLE.

In the foregoing Triangle, the Square of the greateſt Side A C 50, is	2500
The Square of the Side A B 36, is	1296
Added together, make	3796
From which ſubtract the Square of the leaſt Side	400
Remains	3396
The half	1698

Which 1698 divide by 50 the longeſt Side, the Quotient is 33 $\frac{2}{50}$, the Baſe of the greater Right-angled Triangle, *viz.* A D; and that being ſubtracted out of 50, leaves 16 $\frac{2}{50}$ for the Baſe of the ſmaller Right-angled Triangle, *viz.* D C.

CASE

CASE X.

The three Sides of an Oblique Triangle being given, how to find the ſuperficial Content without knowing the Perpendicular.

From half the Sum of the three Sides ſubtract each particular Side. Add the Logarithms of the three Differences, alſo the Logarithm of half the Sum of the three Sides together. Half the Total is the Logarithm of the Content required.

In the foregoing Triangle, the Sides are 50, 36, 20, their Sum is 106; the half Sum 53.

The Differences between the half Sum and each particular Side, are

	3	Log.0.477121
	17	1.230449
	33	1.518514
The half Sum	53	1.724276
Total added		4.950360
The half		2.475180

The Number anſwering to that Log. is 298, which is the Content of the Triangle required.

By Vulgar Arithmetick thus.

Multiply the firſt Difference by the ſecond, that Product by the third, that Product by the half Sum. Laſtly, Extract the Square Root, and you have the ſuperficial Content. So 3 multiplied by 17 makes 51; which multiplied by 33, makes 1683; that multiplied by 53, the half Sum makes 89199; the Square Root of which is 298, the Content required.

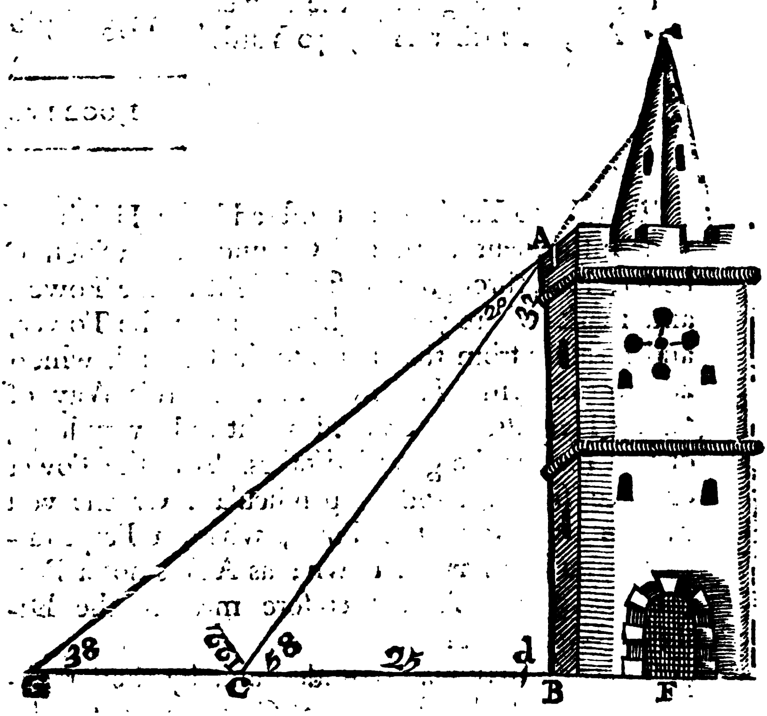
CHAP. XIII.

Of Heights and Diſtances.

How to take the Height of a Tower, Steeple, Tree, or any ſuch thing.

LET AB be a Tower, whoſe Height you would know.

First, At any convenient Diſtance, as at C, place your Semicircle, or what other Inſtrument you judge moſt fit for the taking an Angle of Altitude, as a large Quadrant, or the like, and there obſerve the Angle ACB. But to be more plain, place your Semicircle at C; and having turn'd it down by a Plumb, make it ſtand horizontal; which it does when a Plummet-line fix'd to the Centre falls juſt upon 90 deg. (in ſome Semicircles there is a Line on the Back-ſide of the Braſs Limb, on purpoſe for the ſetting it horizontal.) Then (firſt ſcrewing the Inſtrument faſt) move the Index up and down, till through the Sights you eſpy the top of the Tower at A; ſee then what Degree upon the Limb are cut by the Index, which let be 58, ſo much is your Angle of Altitude. Meaſure next the Diſtance between your Inſtrument and the Foot of the Tower, *viz.* the Line C D, which let



be 25 Yards; then have you all the Angles given, (admitting the Angle of the Tower makes with the Ground, *viz.* *d* to be the right Angle) and the Baſe to find the Perpendicular A B; which you may do, as you were taught in *Caſe* I. of *Trigonometry:* For if you take 58 from 90, there remains 32 for the Angle at A. Then ſay,

As the Sine of the Angle A 32	9,724210
is to the Log. of the Baſe C D 25	1,397940
So is the Sine of the Angle C 58	9,928420
to the Log. Heighth of the Tower A B, or rather A D, 40 Yards	11,326360
	1,602150

To this 40 Yards you muſt add the Height of your Inſtrument from the Ground; or, which is better, look through your fixed Sight to the Tower, and mark where your Sight falls upon the Tower, and meaſure from that Place to the Ground, which add to the former Height found. In this Way of taking Heights, the Ground ought to be very level, or you may make great Miſtakes. Alſo the Tower or Tree ſhould ſtand perpendicular: Or elſe you muſt meaſure to ſuch a Place, where a Perpendicular would fall if let down; as A B is not a Perpendicular, but A *d*; therefore meaſure the Diſtance C *d* for your Baſe.

This you may plainly underſtand by the foregoing Figure; for if ſtanding at C, you were to take the Height of the Tower and Steeple to E, the Angle E C B is the ſame as the Angle at A C B; and if you meaſure only C B or C D, you will make the Height F E the ſame as D A; which by the Figure you plainly perceive to be a great Error: therefore to take the Height F E, you ſhould meaſure from C to F.

How

How to take the Height of a Tower, &c. when you cannot come nigh the Foot thereof.

In the foregoing Figure, let A B be the Tower; and ſuppoſe C B to be a Moat, or ſome other Hindrance, that you cannot come nigher than C to take the Height. Therefore at C place your Inſtrument, and take (as before) the Angle ACB 58 *deg.* Then go backwards any convenient Diſtance, as to G, there alſo take the Angle A G B 38 deg. This done, ſubtract 58 from 180, ſo have you 122 deg. the Angle A C G. Then 122 and 38 being taken from 180, remain 20 for the Angle G A C. The Diſtance G C meaſured, is 26. Now by *Trigonometry* ſay,

As the Sine of the Angle A 20	9534052
is to the Log. of the Diſtance G C 26	1414973
So is the Sine of the Angle G 38	9789342
	11204315
to the Log. of the Line A C 47	1,670263

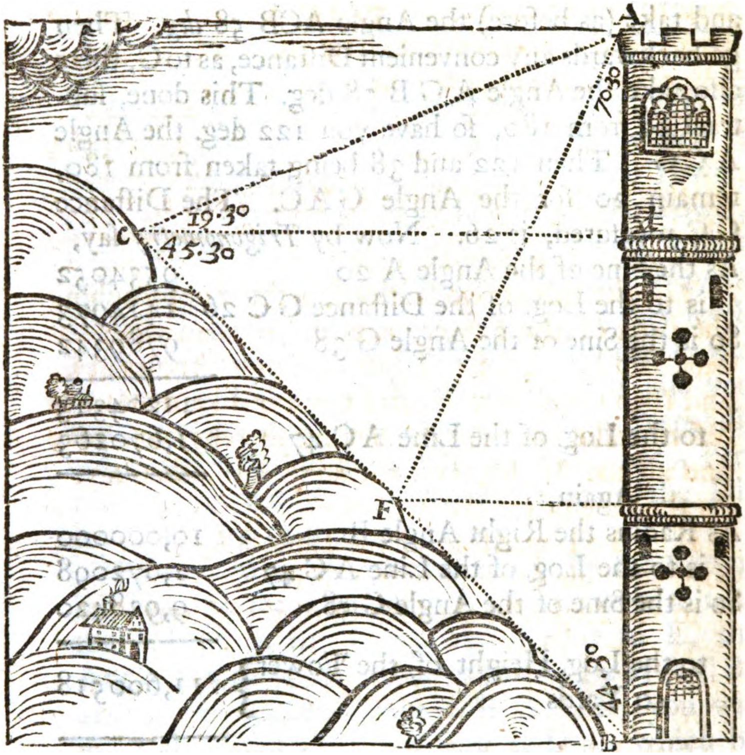
Again,

As Radius the Right Angle B	10,000000
is to the Log. of the Line A C 47	1,672098
So is the Sine of the Angle C 58	9,928420
to the Log. Height of the Tower 40 Yards	11,600518

But ſtill, as I told you before, the Ground is underſtood to be level. However, if it be not, I will ſhew you,

How to take the Height of a Tower, &c. when the Ground either riſeth or falleth.

A B is the Tower, C B the Hill whereon you are to take the Height of the Tower; plant your Semicircle in any Place of the Hill, as at C; then turn it down, and make it ſtand horizontal, as before directed, the Diameter then pointing to *d* of the



the Tower, turn the moveable Index to A, and take the Angle A C *d*; which let be 19 Degrees, 30 Minutes. Take alſo the Angle *d* C B, which is 45 Degrees, 30 Minutes; meaſure alſo the Diſtance C B 56 Yards; take 19 Degrees, 30 Minutes, out of 90 Degrees, 0 Minutes, there remains 70 Degrees, 30 Minutes, for the Angle at A; then ſay,

As Sine 70° : 30′	9974346
is to the Diſtance C B 56 Yards, Log.	1748188
So are both the Angles at C 19 30, and 45 30, *viz.* 65° 0′ Sine	9957276
	11705464
to the Height of the Tower 54 Yards, Log.	1,731118

To take this at two Stations, without approaching the Foot of the Tower, is no more than what has been ſaid before; for if you take your Angles at C, and then meaſure to F, and there in like manner as before, take your Angles again, thereby you may find all the Angles, and the Line A F; then ſay,

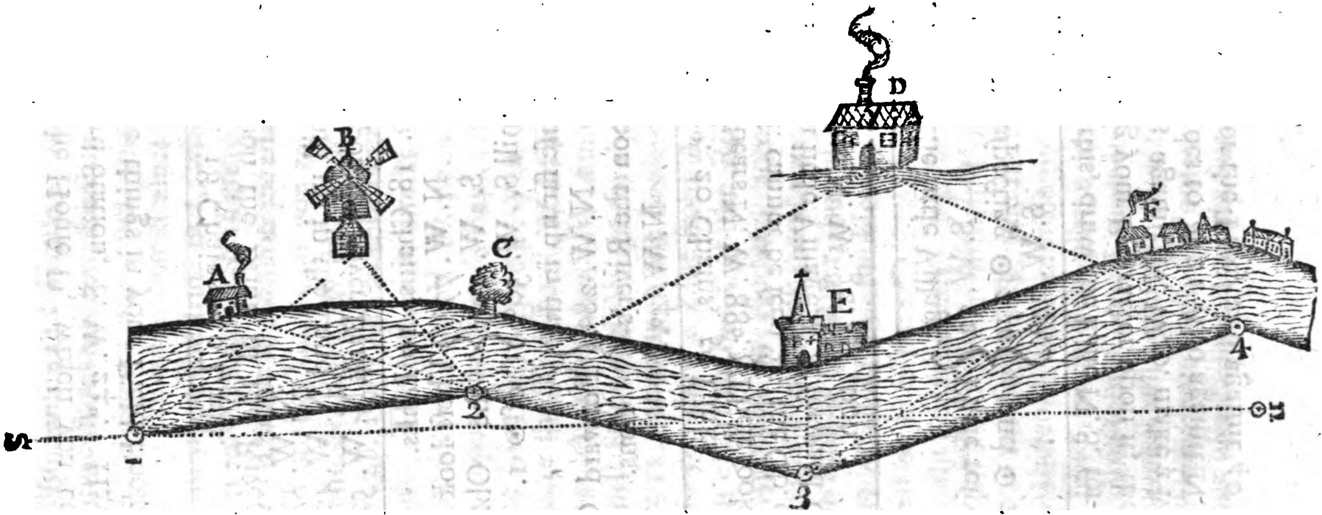
As the Sine of the Angle A B F
is to the Logarithm of the Line F A,
So is the Sine of the Angle A F B
to the Logar. of the Height of the Tower A B.

Of Diſtance.

Altho' I have before ſhewed how to take Diſtance by ſurveying a Field at two Stations, yet ſince it ſeems naturally to come in here again, I will give you one Example thereof: Suppoſe this following Figure to be a Piece of a River, and you meaſuring along one Side of it, would as well know the Breadth of it, as alſo make a true Plot thereof, by putting down what remarkable Things are ſeen on the other Side.

Beginning at ⊙ 1, the firſt Station, cauſe one of your Aſſiſtants to go to the next Bend of the River, as ⊙ 2, and there ſet up a Mark for you; then ſee what Angle from the Meridian ⊙ 1, ⊙ 2 makes, which let be N. 6 deg. W.: Alſo ſeeing ſeveral Marks on the other Side of the River, taking their Bearings, as the Houſe A, which ſtands upon the Bank, and is a good Mark; for the Breadth of the River bears N. W. 52 deg. the Wind-mill B up in the Land bears N. W. 40 deg. the Tree C by the Water-ſide bears N. W. 17 deg. All this note down in your Field-Book, and meaſure the Diſtance ⊙ 1, ⊙ 2, 18 Chains, 20 Links. After this, coming to ⊙ 2, ſee how the next Bend of the River bears from you, *viz.* ⊙ 3; which is N. E. 15 deg. See alſo how the Houſe A there bears from you, *viz.* S. W. 20 deg. the Wind-mill S. W. 50 deg. the Tree N. W. 77. Alſo as you are going forward, if you ſee any thing more at this ſecond Station, taking the Bearing thereof, as a noted Houſe D up in the Land bears N. W. 28°. and a Church E cloſe by the River's Brink N. W. 4°. Meaſure the Diſtance 2, 3, and placing your Inſtrument at 3, the Church bears from you N. W. 88 deg. The Houſe up in the Land D you cannot ſee for the Church, therefore let it alone for the next Station. But here you may ſee forward a little Village F, the firſt Houſe whereof bears from you N. W. 32 deg. Meaſure the Diſtance 3, 4, and planting your Inſtrument in 4, the firſt Houſe of the Village F bears from you S. W.

32


S
1
A
B
C
2
D
E
3
F
4
N

32 deg. and the Houſe D, which you could not ſee at the third Station, S. W. 24°. Having put down all theſe things in your Field-Book, it will look thus:

⊙ 1 N. W. 6°. 18 Chains, 20 Links.

Obſervation.
A Tree upon the Brink of the River bears N. W. 17°. 00′.
A Wind-mill up in the Land N. W. 40°. 00′.
A Houſe upon the River-Bank N. W. 52°. 00′.

⊙ 2 N. E. 15°. 18 Chains, 10 Links.

The Tree	N. W. 77°.	Theſe look back to the Obſervation of ⊙ 1.
The Houſe	S. W. 20°.	
The Wind-mill	S. W. 50°.	
A noted Houſe far up in the Land	N. W. 28°.	Forward Obſervations.
A Church upon the River's-Bank	N. W. 4°.	

⊙ 3 N. W. 15°. 20 Chains, 50 Links.

The Church bears	N. W. 88°.	Theſe look back to the Ob. of ⊙ 2.
The noted H. cannot be ſeen.		
The End of a little Village.	N. W. 32.	A forward Obſervation.

⊙ 4 ——————

The End of the little Village.	S. W. 32.	Theſe reſpect ⊙ 3 and ⊙ 2.
The Houſe reſpecting ⊙ 2 in the Land.	S. W. 24°.	

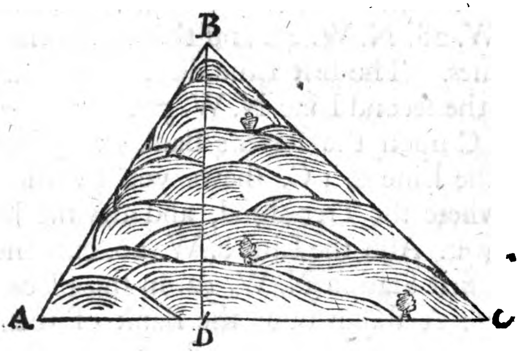
To protract this, draw the Line N. S. for a Meridian, and laying your Protractor upon it, the Centre thereof to ⊙ 1; againſt N. W. 6. make a Mark for the Line that goes to ⊙ 2: Alſo againſt N. W. 17. make a Mark for the Tree, and againſt 40 and 52, for the Wind-mill and Houſe. Then from ⊙ 1 through theſe Marks, draw the Lines ⊙ A, ⊙ B, ⊙ C, ⊙ 2.

Secondly, Take from your Scale 18 Ch. 20 Lin. and ſet it off upon the Line ⊙ a, which will reach to ⊙ 2. There lay again the Centre of your Protractor, the Diameter thereof parallel to the Line N. S.; and make Marks, as you ſee in the Field-Book, againſt N. E. 15. N. W. 77. S. W. 20. S. W. 50. N. W. 28. N. W. 40. and through theſe Marks draw Lines. The firſt Line directs to your third Station, the ſecond Line N. W. 77. directs you to the Tree C upon the River's Bank; for that Line cutting the Line ⊙ 1 C, ſhews you by the Interſection where the Tree ſtood, and alſo the Breadth of the River. Alſo the Line S. W. 20. cuts the Line from the firſt Station N. W. 52. in the Place where the Houſe A ſtands upon the Bank of the River. If therefore you draw a Line from A to C, it will repreſent the farther Bank of the River. And ſo you may proceed on Plotting, according to the Notes in your Field-Book; and you will not only have a true Plot of the River, but alſo know how far the Wind-mill B, and the Houſe D, ſtand from the Water-ſide.

How to take the Horizontal Line of a Hill.

When you meaſure a Hill, you muſt meaſure the Superficies thereof, and accordingly caſt up the Contents. But when you plot it down, becauſe you cannot make a Convex Superficies upon the Paper, you muſt only plot the Horizontal or Baſe thereof; which you muſt ſhadow over with the Reſemblance of a Hill, that other Surveyors, when they apply your Scale thereto, may not ſay you were miſtaken. And you may find this Horizontal or Baſe-Line after the ſame manner as you have been taught to take Heights.

For ſuppoſe A B C D a Hill, whoſe Baſe you would know. Plant your Semicircle at A, and cauſe a Mark to be ſet up at B, ſo high above the top of the Hill, as the Inſtrument ſtands from the Ground at A; and making your Inſtrument horizontal, take the Angle B A D 58 deg. Meaſure the Diſtance A B 16 Chains, 80 Links; then ſay,



As Radius	10000000
is to the Line A B 16 Ch. 80 Lin.	3225309
So is the Sine Complement of A 58°	9724210
to Part of the Baſe A D 8 Ch. 90 Lin.	12,949519

But if you have occaſion to meaſure the whole Hill, plant again your Inſtrument at B, and take the Angle C B D, which let be 46 deg. Meaſure alſo the Diſtance B C 21 Chains; then ſay,

As Radius 10000000
is to the Line BC 21 Ch. 0 Lin. (Log.) 1322219
So is the Sine of the Angle CBD 46 9856934

to the Part of the Baſe DC 15 Ch. 11 L. 11,179153

Which 15. 11. added to 8. 90. makes 24 Chains, 1 Link, for the whole Baſe AG; which is to be plotted, and not AB and BC; although they are to be meaſured to find the Content of the Land.

I mentioned this Way, for your better underſtanding how to take the Baſe of Part of a Hill; for many times your Survey ends upon the Side of a Hill. But if you find you are to take in the whole Hill, you need not take altogether ſo much pains as by the former Way. As thus: Take, as before, the Angle A 58 deg. Meaſure alſo AB. Then at B take the whole Angle ABC 78 deg. Subtract theſe two from 180 deg. remains 44 for the Angle at C; then ſay,

As the Sine of the Angle C 44
is to the Log. of the Side AB,
So is the Sine of the Angle ABC
to the Log. of the Baſe AC.

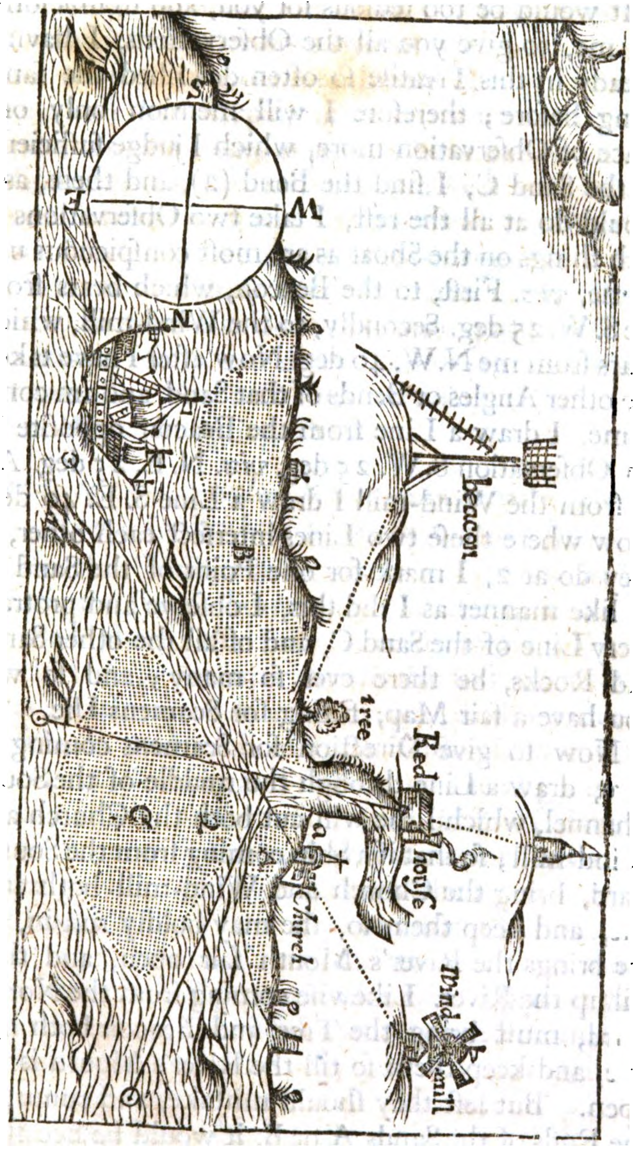
How to take the Shoals of a River's Mouth, and Plot the ſame.

Meaſure firſt the Sea-coaſt on both Sides of the River's Mouth, as far as you think you ſhall have occaſion to make uſe thereof; and make a fair Draught thereof, putting down every remarkable thing in its true Situation, as Trees, Houſes, Towns, Wind-mills, *&c.* Then going out in a Boat to ſuch

Sands or Rocks as make the Entrance difficult, at every conſiderable Bend of the Sands, take with a Sea-Compaſs the Bearing thereof to two known Marks upon the Shore; and having ſo gone round all the Sands and Rocks, you may eaſily upon the Plot before taken, draw Lines which ſhall interſect each other at every conſiderable Point of the Sands; whereby you may truly prick out the Sands, and give good Directions either for laying Buoys, or making Marks upon the Shore for the Direction of Shipping.

EXAMPLE.

Suppoſe the following Figure to be a Piece of ſome Sea-Coaſt. Firſt, I make a fair Draught of it, with the Mouth of the River as far up as there is occaſion, putting down every remarkable thing, as you ſee here, all but the Rocks and Sands excepted, which I am now going to ſhew you how to take. Go in a Boat down the River, till you find the Beginning of the firſt Sand A, as at *a*, and there take a Sight to the Red-Houſe, which let be S. W. 86 deg. alſo to the Tree, which is S. E. 6 deg. To plot which, draw Lines quite contrary to your Obſervations; as from the Red-Houſe draw a Line N. E. 86. and from the Tree a Line N. W. 6 deg. which two Lines will interſect each other in the Point *a*, which ſhews you the Beginning of the Sand A. Row along the ſame Sand, ſounding as you go, till you find it have a conſiderable Bending, and there take again two Obſervations, as before, and protract them too, when yuu come a-ſhore, in like manner. The like do at the Bending of every Sand, till either you come round the



the Sand, or come to the Place where it joins with the Shoar.

It would be too tedious for you, and troubleſome for me, to give you all the Obſervations, I having already in this Treatiſe ſo often deſcribed the ſame thing before; therefore I will mention only one Place of Obſervation more, which I judge ſufficient. In the Sand C, I find the Bend (2), and there, as I ſhould do at all the reſt, I take two Obſervations to ſuch things on the Shoar as are moſt conſpicuous unto me, *viz.* Firſt, to the Beacon, which bears from me S. W. 25 deg. Secondly, to the Wind-mill, which bears from me N. W. 40 deg. Now after I have taken the other Angles or Bends of that Sand, and am come home, I draw a Line from the Beacon oppoſite to my Obſervation S. W. 25 deg. *viz.* N. E. 25 deg. Alſo from the Wind-mill I draw a Line S. E. 40 deg. Now where theſe two Lines interſect each other, as they do at 2, I mark for one Point of the Sand C. In like manner as I did this, I obſerve and protract every Line of the Sand C, and of all the other Sands and Rocks, be there ever ſo many; and ſo will you have a fair Map, fitting for Seamens Uſe.

Now to give Direction for Seamens coming in here, draw a Line through the middle of the South Channel, which Line will cut both the Church and Wind-mill; ſo that if a Ship coming from the Southward, bring the Church and Wind-mill both into one, and keep them ſo, ſhe may boldly run in, till ſhe brings the River's Mouth fair open, and then ſail up the River. Likewiſe coming from the Northward, muſt bring the Tree and Beacon both into one, and keep them ſo till the River's Mouth is fair open. But leſt they ſhould miſtake, and run upon the Ends of the Sands A or B, it would be neceſſary that a Mark was ſet up behind the Red-Houſe, in a ſtrait Line with the middle of the River, as .

Then a Ship coming from the Southward, or Northward, let her keep her former Marks both in one, till ſhe bring the Red-Houſe and both in one; and then keeping them ſo, run boldly up the River, till all Danger is paſt. I have put down this Wind-mill and Beacon, not as if ſuch good Marks would always happen; but to ſhew you how to place Marks, or lay Buoys if it be required.

You muſt mind, after you have taken all the Sands, to take the Sounding alſo quite croſs the Channels, all up and down, and to put them down accordingly; the beſt time of doing which, is at Low-Water in Spring-Tides.

How to know whether Water may be made to run from a Spring-head to any appointed Place.

For this Work, the Diameter of the Semicircle is a little too ſhort; however, an indifferent Shift may be made therewith; but it is better to get a Water-level, ſuch as you may buy at the Inſtrument-Makers; with which being provided, as alſo with two Aſſiſtants, and each of them with a Staff divided into Feet, Inches, and Parts of an Inch, go to the Spring-head; and cauſing your firſt Aſſiſtant to ſtand there with his Staff perpendicular, make the other go in a right Line towards the Place deſigned for bringing the Water any convenient Diſtance, as 100, 150, or 200 Yards, and there let him ſtand, and hold his Staff perpendicular alſo. Then ſet your Inſtrument nigh the Mid-way between 'em, making it ſtand level or horizontal; and look through the Sights thereof to your firſt Aſſiſtant's Staff, he moving a Piece of white Paper up and down the Staff, according to the Signs you make to him, till through the Sights you eſpy the very Edge of the

Paper. Then by a Sign make him to underſtand that you have done with him; and let him write down how many Feet, Inches and Parts the Paper reſted upon. Alſo going to the other End of your Level, do the ſame by the ſecond Aſſiſtant, and let him write down alſo what Number of Feet, *&c.* the Paper was from the Ground. This done, let your firſt Aſſiſtant come to the ſecond Aſſiſtant's Place, and there let him again ſtand with his Staff; and let the ſecond Aſſiſtant go forward 100, 200 Yards, as before; and placing yourſelf and Inſtrument in the midſt between them, take your Obſervations altogether as before, and let them put them down in like manner. And ſo muſt you do till you come to the Place whereto the Water is to be conveyed. Then examine the Names of both your Aſſiſtants, and if the Notes of the ſecond Aſſiſtant exceed that of the firſt, you may be ſure the Place is lower than the Spring-head, and that therefore Water may be well conveyed. But if the firſt's Notes exceed the ſecond's, you may conclude it impoſſible without Engines, or the like.

The firſt Aſſiſtant's Note.

Stat.	Feet.	Inch.	Parts.
⊙ 1	4	3	5
⊙ 2	12	4	2
⊙ 3	3	5	1
	20	0	8

The ſecond Aſſiſtant's Note.

Stat.	Feet.	Inch.	Parts.
⊙ 1	14	5	1
⊙ 2	4	6	3
⊙ 3	9	2	4
	28	1	8

Here you may ſee the ſecond Aſſiſtant's Note exceeds the firſt, 8 Foot, 1 Inch; which is enough to bring the Water with a ſtrong Current, and to make it alſo riſe up 6 or 7 Foot in the Houſe, if occaſion be; for ſuch as have written of this Matter, allow but 4 Inches and ½ Fall in a Mile to make the Water run.

A

TABLE

OF THE

Northing or Southing, Eaſting or Weſting, of every Degree from the Meridian, according to the Number of Chains run upon any DEGREE.

A Table of Northing or Southing,

	1 Deg.			2 Deg.			3 Deg.	
Distance.	N S	E W	Distance.	N S	E W	Distance.	N S	E W
1	1.0	.0	1	1.0	.0	1	1.0	.1
2	2.0	.0	2	2.0	.1	2	2.0	.1
3	3.0	.0	3	3.0	.1	3	3.0	.1
4	4.0	.1	4	4.0	.1	4	4.0	.2
5	5.0	.1	5	5.0	.2	5	5.0	.2
6	6.0	.1	6	6.0	.2	6	6.0	.3
7	7.0	.1	7	7.0	.2	7	7.0	.4
8	8.0	.1	8	8.0	.3	8	8.0	.4
9	9.0	.2	9	9.0	.3	9	9.0	.5
10	10.0	.2	10	10.0	.3	10	10.0	.5
20	20.0	.4	20	20.0	.7	20	20.0	1.0
30	30.0	.5	30	30.0	1.0	30	30.0	1.6
40	40.0	.7	40	40.0	1.4	40	40.0	2.1
50	50.0	.9	50	50.0	1.7	50	50.0	2.6
60	60.0	1.1	60	60.0	2.1	60	59.9	3.1
70	70.0	1.2	70	70.0	2.4	70	69.9	3.7
80	80.0	1.4	80	80.0	2.8	80	79.9	4.2
90	90.0	1.6	90	89.9	3.1	90	89.9	4.7
100	100.0	1.8	100	99.9	3.5	100	99.9	5.2
Dist.	E W	N S	Dist.	E W	N S	Dist.	E W	N S
	89 Deg.			88 Deg.			87 Deg.	

Eaſting or Weſting.

	4 Deg.			5 Deg.			6 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	1.0	.1	1	1.0	.1	1	1.0	.1
2	2.0	.1	2	2.0	.2	2	2.0	.2
3	3.0	.2	3	3.0	.3	3	3.0	.3
4	4.0	.3	4	4.0	.3	4	4.0	.4
5	5.0	.3	5	5.0	.4	5	5.0	.5
6	6.0	.4	6	6.0	.5	6	6.0	.6
7	7.0	.5	7	7.0	.6	7	7.0	.7
8	8.0	.6	8	8.0	.7	8	8.0	.8
9	9.0	.6	9	9.0	.8	9	8.9	.9
10	10.0	.7	10	10.0	.9	10	9.9	1.0
20	20.0	1.4	20	20.0	1.7	20	19.9	2.1
30	29.9	2.1	30	29.9	2.6	30	29.8	3.1
40	39.9	2.8	40	39.8	3.5	40	39.8	4.2
50	49.9	3.5	50	49.8	4.4	50	49.7	5.2
60	59.9	4.2	60	59.8	5.2	60	59.7	6.3
70	69.8	4.9	70	69.7	6.1	70	69.6	7.3
80	79.8	5.6	80	79.7	7.0	80	79.6	8.3
90	89.8	6.3	90	89.7	7.9	90	89.5	9.4
100	99.8	7.0	100	99.6	8.7	100	99.5	10.4
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	86 Deg.			85 Deg.			84 Deg.	

A Table of Northing or Southing,

	7 Deg.			8 Deg.			9 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	1.0	.1	1	1.0	.1	1	1.0	.2
2	2.0	.2	2	2.0	.3	2	2.0	.3
3	3.0	.4	3	3.0	.4	3	3.0	.5
4	4.0	.5	4	4.0	.6	4	4.0	.6
5	5.0	.6	5	5.0	.7	5	5.0	.8
6	6.0	.7	6	5.9	.8	6	5.9	.9
7	6.9	.8	7	6.9	1.0	7	6.9	1.1
8	7.9	1.0	8	7.9	1.1	8	7.9	1.3
9	8.9	1.1	9	8.9	1.3	9	8.9	1.4
10	9.9	1.2	10	9.9	1.4	10	9.9	1.6
20	19.9	2.4	20	19.8	2.8	20	19.8	3.1
30	29.8	3.7	30	29.7	4.2	30	29.6	4.7
40	39.7	4.9	40	39.6	5.6	40	39.5	6.3
50	49.6	6.1	50	49.5	7.0	50	49.4	7.8
60	59.6	7.3	60	59.4	8.3	60	59.8	9.4
70	69.5	8.5	70	69.3	9.7	70	69.1	10.9
80	79.4	9.8	80	79.2	11.1	80	79.0	12.5
90	89.3	11.0	90	89.1	12.5	90	88.9	14.1
100	99.3	12.2	100	99.0	13.9	100	98.8	15.6
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	83 Deg.			82 Deg.			81 Deg.	

Easting or Westing.

	10 Deg.			11 Deg.			12 Deg.	
Distance.	N.S.	EW	Distance.	N.S.	EW	Distance.	N.S.	EW
1	1.0	.2	1	1.0	.2	1	1.0	.2
2	2.0	.3	2	2.0	.4	2	2.0	.4
3	3.0	.5	3	2.9	.6	3	2.9	.6
4	3.9	.7	4	3.9	.8	4	3.9	.8
5	4.9	.9	5	4.9	.9	5	4.9	1.0
6	5.9	1.0	6	5.9	1.1	6	5.9	1.2
7	6.9	1.2	7	6.9	1.3	7	6.9	1.5
8	7.9	1.4	8	7.8	1.5	8	7.8	1.7
9	8.9	1.6	9	8.8	1.7	9	8.8	1.9
10	9.9	1.7	10	9.8	1.9	10	9.8	2.1
20	19.7	3.5	20	19.6	3.8	20	19.6	4.2
30	29.6	5.2	30	29.4	5.7	30	29.3	6.2
40	39.4	6.9	40	39.3	7.6	40	39.1	8.3
50	49.2	8.7	50	49.1	9.5	50	48.9	10.4
60	59.1	10.4	60	58.9	11.4	60	58.7	12.5
70	68.9	12.1	70	68.7	13.4	70	68.5	14.6
80	78.8	13.9	80	78.5	15.3	80	78.3	16.6
90	88.6	15.6	90	88.3	17.2	90	88.0	18.7
100	98.5	17.4	100	98.1	19.1	100	97.8	20.8
Dist.	EW	N.S.	Dist.	EW	N.S.	Dist.	EW	N.S
	80 Deg.			79 Deg.			78 Deg.	

A Table of Northing or Southing,

Diſtance.	13 Deg.		Diſtance.	14 Deg.		Diſtance.	15 Deg.	
	N S	EW		N S	EW		N S	EW
1	1.0	.2	1	1.0	.2	1	1.0	.3
2	2.0	.4	2	1.9	.5	2	1.9	.5
3	2.9	.7	3	2.9	.7	3	2.9	.8
4	3.9	.9	4	3.9	1.0	4	3.9	1.0
5	4.9	1.1	5	4.8	1.2	5	4.8	1.3
6	5.9	1.3	6	5.8	1.4	6	5.8	1.6
7	6.8	1.6	7	6.8	1.7	7	6.8	1.8
8	7.8	1.8	8	7.8	1.9	8	7.7	2.1
9	8.8	2.0	9	8.7	2.2	9	8.7	2.3
10	9.8	2.2	10	9.7	2.4	10	9.7	2.6
20	19.5	4.5	20	19.4	4.8	20	19.3	5.2
30	29.2	6.7	30	29.1	7.3	30	29.0	7.8
40	39.0	9.0	40	38.8	9.7	40	38.6	10.3
50	48.7	11.2	50	48.5	12.1	50	48.3	12.9
60	58.5	13.5	60	58.2	14.5	60	58.0	15.5
70	68.2	15.7	70	67.9	16.9	70	67.6	18.1
80	78.0	18.0	80	77.6	19.4	80	77.3	20.7
90	87.7	20.2	90	87.3	21.8	90	86.9	23.3
100	97.4	22.5	100	97.0	24.2	100	96.6	25.9
Diſt.	EW	N S	Diſt.	EW	N S	Diſt.	EW	N S
	77 Deg.			76 Deg.			75 Deg.	

Eaſting or Weſting.

	16 Deg.			17 Deg.			18 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	1.0	.3	1	1.0	.3	1	1.0	.3
2	1.9	.6	2	1.9	.6	2	1.9	.6
3	2.9	.8	3	2.9	.9	3	2.8	.9
4	3.8	1.1	4	3.8	1.2	4	3.8	1.2
5	4.8	1.4	5	4.8	1.5	5	4.7	1.5
6	5.8	1.7	6	5.7	1.7	6	5.7	1.8
7	6.7	1.9	7	6.7	2.0	7	6.6	2.2
8	7.7	2.2	8	7.6	2.3	8	7.6	2.5
9	8.6	2.5	9	8.6	2.6	9	8.5	2.8
10	9.6	2.8	10	9.6	2.9	10	9.5	3.1
20	19.2	5.5	20	19.1	5.8	20	19.0	6.2
30	28.8	8.3	30	28.7	8.8	30	28.5	9.3
40	38.4	11.0	40	38.3	11.7	40	38.0	12.4
50	48.1	13.8	50	47.8	14.6	50	47.6	15.4
60	57.7	16.5	60	57.4	17.5	60	57.1	18.5
70	67.3	19.3	70	66.9	20.5	70	66.6	21.6
80	76.9	22.0	80	76.5	23.4	80	76.1	24.7
90	86.5	24.8	90	86.1	26.3	90	85.6	27.8
100	96.1	27.6	100	95.6	29.2	100	95.1	30.9
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	74 Deg.			73 Deg.			72 Deg.	

A Table of Northing or Southing,

	19 Deg.			20 Deg.			21 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	.9	.3	1	.9	.3	1	.9	.4
2	1.9	.6	2	1.9	.7	2	1.9	.7
3	2.8	1.0	3	2.8	1.0	3	2.8	1.1
4	3.8	1.3	4	3.8	1.4	4	3.7	1.4
5	4.7	1.6	5	4.7	1.7	5	4.7	1.8
6	5.7	2.0	6	5.6	2.0	6	5.6	2.1
7	6.6	2.3	7	6.6	2.4	7	6.5	2.5
8	7.5	2.6	8	7.5	2.7	8	7.5	2.9
9	8.5	2.9	9	8.5	3.1	9	8.4	3.2
10	9.4	3.3	10	9.4	3.4	10	9.3	3.6
20	18.9	6.5	20	18.8	6.8	20	18.7	7.2
30	28.4	9.8	30	28.2	10.3	30	28.0	10.7
40	37.8	13.0	40	37.6	13.7	40	37.3	14.3
50	47.3	16.3	50	47.0	17.1	50	46.7	17.9
60	56.7	19.5	60	56.4	20.5	60	56.0	21.5
70	66.2	22.8	70	65.8	23.9	70	65.3	25.1
80	75.6	26.1	80	75.2	27.4	80	74.7	28.7
90	85.1	29.3	90	84.6	30.8	90	84.0	32.3
100	94.5	32.6	100	94.0	34.2	100	93.4	35.8
Diſt.	EW	N S	Diſt.	EW	N S	Diſt.	EW	N S
	71 Deg.			70 Deg.			69 Deg.	

Eaſting or Weſting.

	22 Deg.			23 Deg.			24 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	.9	.4	1	.9	.4	1	.9	.4
2	1.9	.7	2	1.8	.8	2	1.8	.8
3	2.8	1.1	3	2.8	1.2	3	2.7	1.2
4	3.7	1.5	4	3.7	1.6	4	3.6	1.6
5	4.6	1.9	5	4.6	1.9	5	4.6	2.0
6	5.6	2.2	6	5.5	2.3	6	5.5	2.4
7	6.5	2.6	7	6.4	2.7	7	6.4	2.8
8	7.4	3.0	8	7.4	3.1	8	7.3	3.2
9	8.3	3.4	9	8.3	3.5	9	8.2	3.7
10	9.3	3.7	10	9.2	3.9	10	9.1	4.1
20	18.5	7.5	20	18.4	7.8	20	18.3	8.1
30	27.8	11.2	30	27.6	11.7	30	27.4	12.2
40	37.1	15.0	40	36.8	15.6	40	36.5	16.3
50	46.4	18.7	50	46.0	19.5	50	45.7	20.3
60	55.6	22.5	60	55.2	23.4	60	54.8	24.4
70	64.9	26.2	70	64.4	27.3	70	63.9	28.5
80	74.2	30.0	80	73.6	31.2	80	73.1	32.5
90	83.4	33.7	90	82.8	35.2	90	82.2	36.6
100	92.7	37.5	100	92.0	39.1	100	91.3	40.7
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	68 Deg.			67 Deg.			66 Deg.	

A Table of Northing or Southing,

	25 Deg.			26 Deg.			27 Deg.	
Distance.	N S	E W	Distance.	N S	E W	Distance.	N S	E W
1	.9	.4	1	.9	.4	1	.9	.5
2	1.8	.8	2	1.8	.9	2	1.8	.9
3	2.7	1.3	3	2.7	1.3	3	2.7	1.4
4	3.6	1.7	4	3.6	1.8	4	3.6	1.8
5	4.5	2.1	5	4.5	2.2	5	4.5	2.3
6	5.4	2.5	6	5.4	2.6	6	5.3	2.7
7	6.3	3.0	7	6.3	3.1	7	6.2	3.2
8	7.2	3.4	8	7.2	3.5	8	7.1	3.6
9	8.1	3.8	9	8.1	3.9	9	8.0	4.1
10	9.1	4.2	10	9.0	4.4	10	8.9	4.5
20	18.1	8.4	20	18.0	8.8	20	17.8	9.1
30	27.2	12.7	30	27.0	13.1	30	26.7	13.6
40	36.2	16.9	40	36.0	17.5	40	35.6	18.2
50	45.3	21.1	50	44.9	21.9	50	44.5	22.7
60	54.4	25.4	60	53.9	26.3	60	53.5	27.2
70	63.4	29.6	70	62.9	30.7	70	62.4	31.8
80	72.5	33.8	80	71.9	35.1	80	71.3	36.3
90	81.6	38.0	90	80.9	39.4	90	80.2	40.9
100	90.6	42.3	100	89.9	43.8	100	89.1	45.4
Dist.	EW	N S	Dist.	EW	N S	Dist.	EW	N S
	65 Deg.			64 Deg.			63 Deg.	

Eaſting or Weſting.

	28 Deg.			29 Deg.			30 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	.9	.5	1	.9	.5	1	.9	.5
2	1.8	.9	2	1.7	1.0	2	1.7	1.0
3	2.6	1.4	3	2.6	1.4	3	2.6	1.5
4	3.5	1.9	4	3.5	1.9	4	3.5	2.0
5	4.4	2.3	5	4.4	2.4	5	4.3	2.5
6	5.3	2.8	6	5.2	2.9	6	5.2	3.0
7	6.2	3.3	7	6.1	3.4	7	6.1	3.5
8	7.1	3.7	8	7.0	3.9	8	6.9	4.0
9	7.9	4.2	9	7.9	4.3	9	7.8	4.5
10	8.8	4.7	10	8.7	4.8	10	8.7	5.0
20	17.7	9.4	20	17.5	9.7	20	17.3	10.0
30	26.5	14.1	30	26.2	14.5	30	26.0	15.0
40	35.3	18.8	40	35.0	19.4	40	34.6	20.0
50	44.1	23.5	50	43.7	24.2	50	43.3	25.0
60	53.0	28.2	60	52.5	29.1	60	52.0	30.0
70	61.8	32.9	70	61.2	33.9	70	60.6	35.0
80	70.6	37.6	80	70.0	38.8	80	69.3	40.0
90	79.5	42.2	90	78.7	43.6	90	77.9	45.0
100	88.3	46.9	100	87.5	48.5	100	86.6	50.0
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	62 Deg.			61 Deg.			60 Deg.	

A Table of Northing or Southing,

	31 Deg.			32 Deg.			33 Deg.	
Diſtance.	N S	EW	Diſtance.	N S	EW	Diſtance.	N S	EW
1	.9	.5	1	.8	.5	1	.8	.5
2	1.7	1.0	2	1.7	1.1	2	1.7	1.1
3	2.6	1.5	3	2.5	1.6	3	2.5	1.6
4	3.4	2.1	4	3.4	2.1	4	3.4	2.2
5	4.3	2.6	5	4.2	2.6	5	4.2	2.7
6	5.1	3.1	6	5.1	3.2	6	5.0	3.3
7	6.0	3.6	7	5.9	3.7	7	5.9	3.8
8	6.9	4.1	8	6.8	4.2	8	6.7	4.4
9	7.7	4.6	9	7.6	4.8	9	7.6	4.9
10	8.6	5.1	10	8.5	5.3	10	8.4	5.4
20	17.1	10.3	20	17.0	10.6	20	16.8	10.9
30	25.7	15.4	30	25.4	15.9	30	25.2	16.3
40	34.3	20.6	40	33.9	21.2	40	33.5	21.8
50	42.9	25.7	50	42.4	26.5	50	41.9	27.2
60	51.4	30.9	60	50.9	31.8	60	50.3	32.7
70	60.0	36.0	70	59.4	37.1	70	58.7	38.1
80	68.6	41.2	80	67.8	42.4	80	67.1	43.6
90	77.1	46.3	90	76.3	47.7	90	75.5	49.0
100	85.7	51.5	100	84.8	53.0	100	83.9	54.5
Diſt.	EW	N S	Diſt.	EW	N S	Diſt.	EW	N S
	59 Deg.			58 Deg.			57 Deg.	

Eaſting or Weſting.

	34 Deg.			35 Deg.			36 Deg.	
Diſtance.	N S	E W	Diſtance.	N S	E W	Diſtance.	N S	E W
1	.8	.6	1	.8	.6	1	.8	.6
2	1.7	1.1	2	1.7	1.1	2	1.6	1.2
3	2.5	1.7	3	2.5	1.7	3	2.4	1.8
4	3.3	2.2	4	3.3	2.3	4	3.2	2.3
5	4.1	2.8	5	4.1	2.9	5	4.0	2.9
6	5.0	3.4	6	4.9	3.4	6	4.8	3.5
7	5.8	3.9	7	5.7	4.0	7	5.6	4.1
8	6.6	4.5	8	6.6	4.6	8	6.4	4.7
9	7.5	5.0	9	7.4	5.2	9	7.2	5.3
10	8.3	5.6	10	8.2	5.7	10	8.1	5.9
20	16.6	11.2	20	16.4	11.5	20	16.2	11.8
30	24.9	16.8	30	24.6	17.2	30	24.3	17.6
40	33.2	22.4	40	32.8	22.9	40	32.4	23.5
50	41.4	28.0	50	41.0	28.7	50	40.4	29.4
60	49.7	33.5	60	49.1	34.4	60	48.5	35.3
70	58.0	39.1	70	57.3	40.2	70	56.6	41.1
80	66.3	44.7	80	65.5	45.9	80	64.7	47.0
90	74.6	50.3	90	73.7	51.6	90	72.8	52.9
100	82.9	55.9	100	81.9	57.4	100	80.9	58.8
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	56 Deg.			55 Deg.			54 Deg.	

A Table of Northing or Southing,

Diſtance.	43 Deg.		Diſtance.	44 Deg.		Diſtance.	45 Deg.	
	N S	E W		N S	E W		N S	E W
1	.7	.7	1	.7	.7	1	.7	.7
2	1.5	1.4	2	1.4	1.4	2	1.4	1.4
3	2.2	2.0	3	2.2	2.1	3	2.1	2.1
4	2.9	2.7	4	2.9	2.8	4	2.8	2.8
5	3.6	3.4	5	3.6	3.5	5	3.5	3.5
6	4.4	4.1	6	4.3	4.2	6	4.2	4.2
7	5.1	4.8	7	5.0	4.9	7	4.9	4.9
8	5.8	5.4	8	5.8	5.6	8	5.6	5.6
9	6.6	6.1	9	6.5	6.2	9	6.4	6.4
10	7.3	6.8	10	7.2	6.9	10	7.1	7.1
20	14.6	13.6	20	14.4	13.9	20	14.1	14.1
30	21.9	20.5	30	21.6	20.8	30	21.2	21.2
40	29.2	27.3	40	28.8	27.8	40	28.3	28.3
50	36.6	34.1	50	36.0	34.7	50	35.3	35.3
60	43.9	40.9	60	43.2	41.7	60	42.4	42.4
70	51.2	47.7	70	50.3	48.6	70	49.5	49.5
80	58.5	54.6	80	57.5	55.6	80	56.6	56.6
90	65.8	61.4	90	64.7	62.5	90	63.6	63.6
100	73.1	68.2	100	71.9	69.5	100	70.7	70.7
Diſt.	E W	N S	Diſt.	E W	N S	Diſt.	E W	N S
	47 Deg.			46 Deg.			45 Deg.	

The USE of the foregoing TABLE.

I Have already ſufficiently, in the ſixth Chapter of this Book, taught you the Uſe of this Table; however, becauſe it is made ſomewhat different from ſuch of this kind as have been made by others, I will briefly, by an Example or two, explain it to you. Admit in ſurveying a Wood, or the like, you run a Line N. E. 40 Degrees, 10 Chains: Or, in plainer Terms, a Line 10 Chains in Length, that makes an Angle with the Meridian of 40 Degrees to the Eaſtward; and you would put down in your Field-Book the Northing and Eaſting of this Line, under their proper Titles N. and E. according to Mr. *Norwood*'s Way of ſurveying, taught in the ſixth Chapter.

Firſt, at the Head of the Table find 40 Degrees, then in the Column of Diſtances ſeek for 10 Chains: Which had, you will find to ſtand right againſt it, under the Title N. 7. 7. for the Northing, which is 7 Chains, $\frac{7}{10}$ of a Chain: And for the Eaſting, under the Title E. 6. 4. which is 6 Chains, $\frac{4}{10}$ of a

Chain, as nigh as may be expreſſed in the tenth Part of a Chain: But if you would know to one Link, add 0 to the Diſtance, ſo will 10 be 100; which ſeek for in the ſame Page of the Table, and right againſt it you will find under Title N. 76.6. or 7 Chains, 66 Links for your Northing; and under Title E. 64. 3. or 6 Chains, 43 Links for your Eaſting: Which found, put down in your Field-Book accordingly; and having done ſo by all your Lines, if you find the Northing and Southing the ſame, alſo the Eaſting and Weſting, you may be ſure you have wrought true, otherwiſe not.

If the Diſtance conſiſts of odd Chains and Links, as moſt commonly it ſo falls out, then take them ſeverally out of the Table, and by adding all together you will have your Deſire. As for Example:

Suppoſe my Diſtance run upon any Line be N. W. 35 Degrees, 15 Chains, 20 Links: N.

	Ch.	Ch.	Lin.
Firſt in the Table I find the Northing of 10 Chains to be———	10	8	19
	5	4	10
	20Lin.	0	16$\frac{4}{10}$
		12	45$\frac{4}{10}$

Which added together, makes 12 Chains, 45 Links $\frac{4}{10}$ for the Northing of that Diſtance run.

In like manner under 35 Deg. and Title W. I find the Weſting of the ſame Line, as here:

Ch.	Ch.	L.
10	5	74
5	2	87
20 Lin.	0	11$\frac{5}{10}$
	8	72$\frac{5}{10}$

By which I conclude the Northing of that Line to be 12 Chains, 45 Links $\frac{4}{10}$, and the Weſting 8 Chains, 72 Links $\frac{5}{10}$: Which thus you may prove by the Logarithms.

As Radius ———————— 10,000000
is to the Diſtance 15.20.———— 3,181844
So is the Sine of the Courſe 35 Deg. — 9,758591

to the Weſting 8 Chains, 72 Links—12,940435

And, As Radius———————— 10,000000
to the Diſtance 15 Chains, 20 Links 3,181844
So Co-ſine of the Courſe 55———— 9,913364

to the Northing 12 Chains, 45 Links 13,095208

Mark, If your Courſe had been S. E. it would have been the ſame thing as N. W.: For you ſee in the Tables N. and S. E. and W. are joined toge-

ther.

ther. If your Degrees exceed 45, then ſeek for them at the Foot of the Table: And over the Titles N. S. E. W. find out the Northing, Southing, Eaſting or Weſting.

I think this to be as much as need be ſaid concerning the preceding Table; As for the finding the Horizontal Line of a Hill, and ſuch like things by the Table, before you have half well read through the Chapter of *Trigonometry*, your own Ingenuity will faſt enough prompt you to it.

A
TABLE
OF
Sines *and* Tangents

To every Fifth Minute

OF THE

QUADRANT.

0.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	0.000000	10.000000	0.000000	Infinita.	60
5	7.162696	9.999999	7.162696	12.837304	55
10	7.463726	9.999998	7.463727	12.536273	50
15	7.639816	9.999996	7.639820	12.360180	45
20	7.764754	9.999993	7.764761	12.235239	40
25	7.861662	9.999989	7.861674	12.138326	35
30	7.940842	9.999983	7.940858	12.059142	30
35	8.007787	9.999977	8.007809	11.992191	25
40	8.065776	9.999971	8.065806	11.934194	20
45	8.116926	9.999963	8.116963	11.883037	15
50	8.162681	9.999954	8.162737	11.837273	10
55	8.204070	9.999944	8.204126	11.795874	5
60	8.241855	9.999934	8.241921	11.758079	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

89.

1.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	8.241855	9.999934	8.241921	11.758079	60
5	8.276614	9.999922	8.276691	11.723309	55
10	8.308794	9.999910	8.308884	11.691116	50
15	8.338753	9.999897	8.338856	11.661144	45
20	8.366777	9.999882	8.366895	11.633105	40
25	8.393101	9.999867	8.393234	11.606766	35
30	8.417919	9.999851	8.418068	11.581932	30
35	8.441394	9.999834	8.441560	11.558440	25
40	8.463665	9.999816	8.463849	11.536151	20
45	8.484848	9.999797	8.485050	11.514950	15
50	8.505045	9.999778	8.505267	11.494733	10
55	8.524343	9.999757	8.524586	11.475414	5
60	8.542810	9.999735	8.543084	11.456916	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

88.

2.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	8.542819	9.999735	8.543084	11.456916	60
5	8.560540	9.999713	8.560828	11.439172	55
10	8.577566	9.999689	8.577877	11.422123	50
15	8.593948	9.999665	8.594283	11.405717	45
20	8.609734	9.999640	8.610094	11.389906	40
25	8.624965	9.999614	8.625352	11.374648	35
30	8.639680	9.999586	8.640093	11.359907	30
35	8.653911	9.999558	8.654352	11.345648	25
40	8.667689	9.999529	8.668160	11.331840	20
45	8.681043	9.999500	8.681544	11.318456	15
50	8.693998	9.999469	8.694529	11.305471	10
55	8.706577	9.999437	8.707140	11.292860	5
60	8.718800	9.999404	8.719396	11.280604	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

87.

3.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	8.718600	9.999404	8.719396	11.280604	60
5	8.730688	9.999371	8.731317	11.268683	55
10	8.742250	9.999336	8.742922	11.257078	50
15	8.753528	9.999301	8.754227	11.245773	45
20	8.764511	9.999265	8.765246	11.234754	40
25	8.775223	9.999227	8.775995	11.224005	35
30	8.785675	9.999189	8.786486	11.213514	30
35	8.795881	9.999150	8.796731	11.203269	25
40	8.805852	9.999110	8.806742	11.103258	20
45	8.815599	9.999069	8.816529	11.183471	15
50	8.825130	9.999027	8.826103	11.173897	10
55	8.834456	9.998984	8.835471	11.164529	5
60	8.843585	9.998941	8.844644	11.155356	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

86.

4.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	8.843585	9.998941	8.844644	11.155356	60
5	8.852525	9.998896	8.853628	11.146372	55
10	8.861283	9.998851	8.862433	11.137567	50
15	8.869868	9.998804	8.871064	11.128936	45
20	8.878285	9.998757	8.879529	11.120471	40
25	8.886542	9.998708	8.887833	11.112167	35
30	8.894643	9.998659	8.895984	11.104016	30
35	8.902596	9.998609	8.903987	11.096013	25
40	8.910404	9.998558	8.911846	11.088154	20
45	8.918073	9.998506	8.919568	11.080432	15
50	8.925609	9.998453	8.927156	11.072844	10
55	8.933015	9.998399	8.934616	11.065384	5
60	8.940296	9.998344	8.941952	11.058048	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

85.

5.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	8.940296	9.998344	8.941952	11.058048	60
5	8.947456	9.998289	8.949168	11.050832	55
10	8.954499	9.998232	8.956267	11.043733	50
15	8.961429	9.998174	8.963255	11.036745	45
20	8.968249	9.998116	8.970133	11.029867	40
25	8.974962	9.998056	8.976906	11.023094	35
30	8.981573	9.997996	8.983577	11.016423	30
35	8.988083	9.997935	8.990149	11.009851	25
40	8.994497	9.997872	8.996624	11.003376	20
45	9.000816	9.997809	9.003007	10.996993	15
50	9.007044	9.997745	9.009298	10.990702	10
55	9.013182	9.997680	9.015502	10.984498	5
60	9.019235	9.997614	9.021620	10.978380	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

84.

6.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.019235	9.997614	9.021620	10.978380	60
5	9.025203	9.997547	9.027655	10.972345	55
10	9.031089	9.997480	9.033609	10.966391	50
15	9.036896	9.997411	9.039485	10.960515	45
20	9.042625	9.997341	9.045284	10.954716	40
25	9.048279	9.997271	9.051008	10.948992	35
30	9.053859	9.997199	9.056659	10.943341	30
35	9.059367	9.997127	9.062240	10.937760	25
40	9.064806	9.997053	9.067752	10.932248	20
45	9.070176	9.996979	9.073197	10.926803	15
50	9.075480	9.996904	9.078576	10.921424	10
55	9.080719	9.996828	9.083891	10.916109	5
60	9.085894	9.996751	9.089144	10.910856	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

83.

7.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.085894	9.996751	9.089144	10.910850	60
5	9.091008	9.996673	9.094336	10.905664	55
10	9.096062	9.996594	9.099468	10.900532	50
15	9.101056	9.996514	9.104542	10.895458	45
20	9.105992	9.996433	9.109559	10.890441	40
25	9.110873	9.996351	9.114521	10.885479	35
30	9.115698	9.996269	9.119429	10.880571	30
35	9.120469	9.996185	9.124284	10.875716	25
40	9.125187	9.996100	9.129087	10.870913	20
45	9.129854	9.996015	9.133839	10.866161	15
50	9.134470	9.995928	9.138542	10.861458	10
55	9.139037	9.995841	9.143196	10.856804	5
60	9.143555	9.995753	9.147803	10.852197	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

82.

The Table of Sines and Tangents.

8.

M	Sine.	Co-ſine,	Tangent.	Co-tang.	
0	9.143555	9.995753	9.147803	10.852197	60
5	9.148026	9.995664	9.152363	10.847637	55
10	9.152451	9.995573	9.156877	10.843123	50
15	9.156830	9.995482	9.161347	10.838653	45
20	9.161164	9.995390	9.165774	10.834226	40
25	9.165454	9.995297	9.170157	10.829843	35
30	9.169702	9.995203	9.174499	10.825501	30
35	9.173908	9.995108	9.178799	10.821201	25
40	9.178072	9.995013	9.183059	10.816941	20
45	9.182196	9.994916	9.187280	10.812720	15
50	9.186280	9.994818	9.191462	10.808538	10
55	9.190325	9.994720	9.195606	10.804394	5
60	9.194332	9.994620	9.199713	10.800287	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

81.

9.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.194332	9.994620	9.199713	10.800287	60
5	9.198302	9.994159	9.203782	10.796218	55
10	9.202234	9.994418	9.207817	10.792183	50
15	9.206131	9.994316	9.211815	10.788185	45
20	9.209992	9.994212	9.215780	10.784220	40
25	9.213818	9.994108	9.219710	10.780290	35
30	9.217609	9.994003	9.223607	10.776393	30
35	9.221367	9.993897	9.227471	10.772529	25
40	9.225092	9.993789	9.231302	10.768698	20
45	9.228784	9.993681	9.235103	10.764897	15
50	9.232444	9.993572	9.238872	10.761128	10
55	9.236073	9.993462	9.242610	10.757390	5
60	9.239670	9.993351	9.246319	10.753681	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

80.

10.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.239670	9.993351	9.246319	10.753681	60
5	9.243237	9.993240	9.249998	10.750002	55
10	9.246775	9.993127	9.253648	10.746352	50
15	9.250282	9.993013	9.257269	10.742731	45
20	9.253761	9.992898	9.260863	10.739137	40
25	9.257211	9.992783	9.264428	10.735572	35
30	9.260633	9.992666	9.267967	10.732033	30
35	9.264027	9.992549	9.271479	10.728521	25
40	9.267395	9.992430	9.274964	10.725036	20
45	9.270735	9.992311	9.278424	10.721576	15
50	9.274049	9.992190	9.281858	10.718142	10
55	9.277337	9.992069	9.285268	10.714732	5
60	9.280599	9.991947	9.288652	10.711348	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

79.

11.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.280599	9.991974	9.288652	10.711348	60
5	9.283836	9.991823	9.292013	10.707987	55
10	9.287048	9.991699	9.295349	10.704651	50
15	9.290236	9.991574	9.298662	10.701338	45
20	9.293399	9.991448	9.301951	10.698049	40
25	9.296539	9.991321	9.305218	10.694782	35
30	9.299655	9.991193	9.308463	10.691537	30
35	9.302748	9.991064	9.311685	10.688315	25
40	9.305819	9.990934	9.314885	10.685115	20
45	9.308867	9.990803	9.318064	10.681936	15
50	9.311893	9.990671	9.321222	10.678778	10
55	9.314897	9.990538	9.324358	10.675642	5
60	9.317879	9.990404	9.327475	10.672525	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

78.

12.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.317879	9.990404	9.327475	10.672525	60
5	9.320840	9.990270	9.330570	10.669430	55
10	9.323780	9.990134	9.333646	10.666354	50
15	9.326700	9.989997	9.336702	10.663298	45
20	9.329599	9.989860	9.339739	10.660261	40
25	9.332478	9.989721	9.342757	10.657243	35
30	9.335337	9.989582	9.345755	10.654245	30
35	9.338176	9.989441	9.348735	10.651265	25
40	9.340996	9.989300	9.351697	10.648303	20
45	9.343797	9.989157	9.354640	10.645360	15
50	9.346579	9.989014	9.357566	10.642434	10
55	9.349343	9.988869	9.360474	10.639526	5
60	9.352088	9.988724	9.363364	10.636636	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

77.

13.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.352088	9.988724	9.363364	10.636636	60
5	9.354815	9.988578	9.366237	10.633763	55
10	9.357524	9.988430	9.369094	10.630906	50
15	9.360215	9.988282	9.371933	10.628067	45
20	9.362809	9.988133	9.374756	10.625244	40
25	9.365546	9.987983	9.377563	10.622437	35
30	9.368185	9.987832	9.380354	10.619646	30
35	9.370808	9.987679	9.383129	10.616871	25
40	9.373414	9.987526	9.385888	10.614112	20
45	9.376003	9.987372	9.388631	10.611369	15
50	9.378577	9.987217	9.391360	10.608640	10
55	9.381134	9.987061	9.394073	10.605927	5
60	9.383675	9.986904	9.396771	10.603229	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

76.

14.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.383675	9.986904	9.396771	10.603229	60
5	9.386201	9.986746	9.399455	10.600545	55
10	9.388711	9.986587	9.402124	10.597876	50
15	9.391206	9.986427	9.404778	10.595222	45
20	9.393685	9.986266	9.407419	10.592581	40
25	9.396150	9.986104	9.410045	10.589955	35
30	9.398600	9.985942	9.412658	10.587342	30
35	9.401035	9.985778	9.415257	10.584743	25
40	9.403455	9.985613	9.417842	10.582158	20
45	9.405862	9.985447	9.420415	10.579585	15
50	9.408254	9.985280	9.422974	10.577026	10
55	9.410632	9.985113	9.425519	10.574481	5
60	9.412996	9.984944	9.428052	10.571948	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

75.

15.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.412996	9.984944	9.428052	10.571948	60
5	9.415347	9.984774	9.430573	10.569427	55
10	9.417684	9.984603	9.433080	10.566920	50
15	9.420007	9.984432	9.435576	10.564424	45
20	9.422318	9.984259	9.438059	10.561941	40
25	9.424616	9.984085	9.440529	10.559471	35
30	9.426899	9.983911	9.442988	10.557012	30
35	9.429170	9.983735	9.445435	10.554565	25
40	9.431429	9.983558	9.447870	10.552130	20
45	9.433675	9.983381	9.450294	10.549706	15
50	9.435908	9.983202	9.452706	10.547294	10
55	9.438129	9.983022	9.455107	10.544893	5
60	9.440338	9.982842	9.457496	10.542504	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

74.

16.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.440338	9.982842	9.457496	10.542504	60
5	9.442535	9.982660	9.459875	10.540125	55
10	9.444720	9.982477	9.462242	10.537758	50
15	9.446893	9.982294	9.464599	10.535401	45
20	9.449054	9.982109	9.466945	10.533055	40
25	9.451204	9.981924	9.469280	10.530720	35
30	9.453342	9.981737	9.471605	10.528395	30
35	9.455469	9.981549	9.473919	10.526081	25
40	9.457584	9.981361	9.476223	10.523777	20
45	9.459688	9.981171	9.478517	10.521483	15
50	9.461782	9.980981	9.480801	10.519199	10
55	9.463864	9.980789	9.483075	10.516925	5
60	9.465935	9.980596	9.485339	10.514661	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

73.

17.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.465935	9.980596	9.485339	10.514661	60
5	9.467996	9.980403	9.487593	10.512407	55
10	9.470446	9.980208	9.489838	10.510162	50
15	9.472086	9.980012	9.492073	10.507927	45
20	9.474115	9.979816	9.494299	10.505701	40
25	9.476133	9.979618	9.496515	10.503485	35
30	9.478142	9.979420	9.498722	10.501278	30
35	9.480140	9.979220	9.500920	10.499080	25
40	9.482128	9.979019	9.503109	10.496891	20
45	9.484107	9.978817	9.505289	10.494711	15
50	9.486075	9.978615	9.507460	10.492540	10
55	9.488034	9.978411	9.509622	10.490378	5
60	9.489982	9.978206	9.511776	10.488224	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

72.

18.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.489982	9.978206	9.511776	10.488222	60
5	9.491922	9.978001	9.513921	10.486076	55
10	9.493851	9.977794	9.516057	10.483943	50
15	9.495772	9.977586	9.518186	10.481814	45
20	9.497682	9.977377	9.520305	10.479695	40
25	9.499584	9.977167	9.522417	10.477583	35
30	9.501476	9.976957	9.524520	10.475480	30
35	9.503360	9.976745	9.526615	10.473385	25
40	9.505234	9.976532	9.528702	10.471298	20
45	9.507099	9.976318	9.530781	10.469219	15
50	9.508956	9.976103	9.532853	10.467147	10
55	9.510803	9.975887	9.534916	10.465084	5
60	9.512642	9.975670	9.536972	10.463028	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

71.

19.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.512642	9.975670	9.536972	10.463028	60
5	9.514472	9.975452	9.539020	10.460980	55
10	9.516294	9.975233	9.541061	10.458939	50
15	9.518107	9.975013	9.543094	10.456906	45
20	9.519911	9.974792	9.545119	10.454881	40
25	9.521707	9.974570	9.547138	10.452862	35
30	9.523495	9.974347	9.549149	10.450851	30
35	9.525275	9.974122	9.551153	10.448847	25
40	9.527046	9.973897	9.553149	10.446851	20
45	9.528810	9.973671	9.555139	10.444861	15
50	9.530565	9.973444	9.557121	10.442879	10
55	9.532312	9.973215	9.559097	10.440903	5
60	9.534052	9.972986	9.561066	10.438934	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

70.

20.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.534052	9.972986	9.561066	10.438934	60
5	9.535783	9.972755	9.563028	10.436972	55
10	9.537507	9.972524	9.564983	10.435017	50
15	9.539223	9.972291	9.566932	10.433068	45
20	9.540931	9.972058	9.568873	10.431127	40
25	9.542632	9.971823	9.570809	10.429191	35
30	9.544325	9.971583	9.572738	10.427262	30
35	9.546011	9.971351	9.574660	10.425340	25
40	9.547689	9.971113	9.576576	10.423424	20
45	9.549360	9.970874	9.578486	10.421514	15
50	9.551024	9.970635	9.580389	10.419611	10
55	9.552680	9.970394	9.582286	10.417714	5
60	9.554329	9.970152	9.584177	10.415823	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

69.

21.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.554329	9.970152	9.584177	10.415823	60
5	9.555971	9.969909	9.586062	10.413938	55
10	9.557606	9.969665	9.587941	10.412059	50
15	9.559234	9.969420	9.589814	10.410186	45
20	9.560855	9.969173	9.591681	10.408319	40
25	9.562468	9.968926	9.593542	10.406458	35
30	9.564075	9.968678	9.595398	10.404602	30
35	9.565676	9.968429	9.597247	10.402753	25
40	9.567269	9.968178	9.599091	10.400909	20
45	9.568856	9.967927	9.600929	10.399071	15
50	9.570435	9.967674	9.602761	10.397239	10
55	9.572009	9.967421	9.604588	10.395412	5
60	9.573575	9.967166	9.606410	10.393590	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

68.

22.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.573575	9.967166	9.606410	10.393590	60
5	9.575136	9.966910	9.608225	10.391775	55
10	9.576689	9.966653	9.610036	10.389964	50
15	9.578236	9.966395	9.611841	10.388159	45
20	9.579777	9.966136	9.613641	10.386359	40
25	9.581312	9.965876	9.615435	10.384565	35
30	9.582840	9.965615	9.617224	10.382776	30
35	9.584361	9.965353	9.619008	10.380992	25
40	9.585877	9.965090	9.620787	10.379213	20
45	9.587386	9.964826	9.622561	10.377439	15
50	9.588890	9.964560	9.624330	10.375670	10
55	9.590387	9.964294	9.626093	10.373907	5
60	9.591878	9.964026	9.627852	10.372148	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

67.

23.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.591878	9.964026	9.627852	10.372148	60
5	9.593363	9.963757	9.629606	10.370394	55
10	9.594842	9.963488	9.631355	10.368645	50
15	9.596315	9.963217	9.633098	10.366902	45
20	9.597783	9.962945	9.634838	10.365162	40
25	9.599244	9.962672	9.636572	10.363428	35
30	9.600700	9.962398	9.638302	10.361698	30
35	9.602150	9.962123	9.640027	10.359973	25
40	9.603594	9.961846	9.641747	10.358253	20
45	9.605032	9.961569	9.643463	10.356537	15
50	9.606465	9.961290	9.645174	10.354826	10
55	9.607892	9.961011	9.646881	10.353119	5
60	9.609313	9.960730	9.648583	10.351417	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

66.

24.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.609313	9.960730	9.648583	10.351417	60
5	9.610729	9.960448	9.650281	10.349719	55
10	9.612140	9.960165	9.651974	10.348026	50
15	9.613545	9.959882	9.653663	10.346337	45
20	9.614944	9.959596	9.655348	10.344652	40
25	9.616338	9.959310	9.657028	10.342972	35
30	9.617727	9.959023	9.658704	10.341296	30
35	9.619110	9.958734	9.660376	10.339624	25
40	9.620488	9.958445	9.662043	10.337957	20
45	9.621861	9.958154	9.663707	10.336293	15
50	9.623229	9.957863	9.665366	10.334634	10
55	9.624591	9.957570	9.667021	10.332979	5
60	9.625948	9.957276	9.668673	10.331327	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

65.

25.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.625948	9.957276	9.668673	10.331327	60
5	9.627300	9.956981	9.670320	10.329680	55
10	9.628647	9.956684	9.671963	10.328037	50
15	9.629989	9.956387	9.673602	10.326398	45
20	9.631326	9.956089	9.675237	10.324763	40
25	9.632658	9.955789	9.676869	10.323131	35
30	9.633984	9.955488	9.678496	10.322504	30
35	9.635306	9.955186	9.680120	10.319880	25
40	9.636623	9.954883	9.681740	10.318260	20
45	9.637935	9.954579	9.683356	10.316644	15
50	9.639242	9.954274	9.684968	10.315032	10
55	9.640544	9.953968	9.686577	10.313423	5
60	9.641842	9.953660	9.688182	10.311818	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

64.

26.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.641842	9.953660	9.688182	10.311818	60
5	9.643135	9.953352	9.689783	10.310217	55
10	9.644423	9.953042	9.691381	10.308619	50
15	9.645706	9.952731	9.692975	10.307025	45
20	9.646984	9.952419	9.694566	10.305434	40
25	9.648258	9.952106	9.696153	10.303847	35
30	9.649527	9.951791	9.697736	10.302264	30
35	9.650792	9.951476	9.699316	10.300684	25
40	9.652052	9.951159	9.700893	10.299107	20
45	9.653308	9.950841	9.702466	10.297534	15
50	9.654558	9.950522	9.704036	10.295964	10
55	9.655805	9.950202	9.705603	10.294397	5
60	9.657047	9.949881	9.707166	10.292834	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

63.

27.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.657047	9.949881	9.707166	10.292834	60
5	9.658284	9.949558	9.708726	10.291274	55
10	9.659517	9.949235	9.710282	10.289718	50
15	9.660746	9.948910	9.711836	10.288104	45
20	9.661970	9.948584	9.713386	10.286614	40
25	9.663190	9.948257	9.714933	10.285067	35
30	9.664406	9.947929	9.716477	10.283523	30
35	9.665617	9.947600	9.718017	10.281983	25
40	9.666824	9.947269	9.719555	10.280445	20
45	9.668027	9.946937	9.721089	10.278911	15
50	9.669225	9.946604	9.722621	10.277379	10
55	9.670419	9.946270	9.724149	10.275851	5
60	9.671609	9.945935	9.725674	10.274326	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

62.

28.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.671609	9.945935	9.725674	10.274326	60
5	9.672795	9.945598	9.727197	10.272803	55
10	9.673977	9.945261	9.728716	10.271284	50
15	9.675155	9.944922	9.730233	10.269767	45
20	9.676328	9.944582	9.731746	10.268254	40
25	9.677498	9.944241	9.733257	10.266743	35
30	9.678663	9.943899	9.734764	10.265236	30
35	9.679824	9.943555	9.736269	10.263731	25
40	9.680982	9.943210	9.737771	10.262229	20
45	9.682135	9.942864	9.739271	10.260729	15
50	9.683284	9.942517	9.740767	10.259233	10
55	9.684430	9.942169	9.742261	10.257739	5
60	9.685571	9.941819	9.743752	10.256248	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

61.

29.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.685571	9.941819	9.743751	10.256248	60
5	9.686709	9.941469	9.745240	10.254760	55
10	9.687843	9.941117	9.746726	10.253274	50
15	9.688972	9.940763	9.748209	10.251791	45
20	9.690098	9.940409	9.749689	10.250311	40
25	9.691220	9.940054	9.751167	10.248833	35
30	9.692339	9.939697	9.752642	10.247358	30
35	9.693453	9.939339	9.754115	10.245885	25
40	9.694564	9.938980	9.755585	10.244415	20
45	9.695671	9.938619	9.757052	10.242948	15
50	9.696775	9.938258	9.758517	10.241483	10
55	9.697874	9.937895	9.759979	10.240021	5
60	9.698970	9.937531	9.761439	10.238561	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

60.

30.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.698970	9.937531	9.761439	10.238561	60
5	9.700062	9.937165	9.762897	10.237103	55
10	9.701151	9.936799	9.764352	10.235648	50
15	9.702236	9.936431	9.765805	10.234195	45
20	9.703317	9.936062	9.767255	10.232745	40
25	9.704395	9.935692	9.768703	10.231297	35
30	9.705469	9.935320	9.770148	10.229852	30
35	9.706539	9.934948	9.771592	10.228408	25
40	9.707606	9.934574	9.773033	10.226967	20
45	9.708670	9.934199	9.774471	10.225529	15
50	9.709730	9.933822	9.775908	10.224092	10
55	9.710786	9.933445	9.777342	10.222658	5
60	9.711839	9.933066	9.778774	10.221226	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

59.

31.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.711839	9.933066	9.778774	10.221226	60
5	9.712889	9.932685	9.780203	10.219797	55
10	9.713935	9.932304	9.781631	10.218369	50
15	9.714978	9.931921	9.783056	10.216944	45
20	9.716017	9.931537	9.784479	10.215521	40
25	9.717053	9.931152	9.785900	10.214100	35
30	9.718085	9.930766	9.787319	10.212681	30
35	9.719114	9.930378	9.788736	10.211264	25
40	9.720140	9.929989	9.790151	10.209849	20
45	9.721162	9.929599	9.791563	10.208437	15
50	9.722181	9.929207	9.792974	10.207026	10
55	9.723197	9.928815	9.794383	10.205617	5
60	9.724210	9.928420	9.795789	10.204211	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

58.

32.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.724210	9.928420	9.795789	10.204211	60
5	9.725219	9.928025	9.797194	10.202806	55
10	9.726225	9.927629	9.798596	10.201404	50
15	9.727228	9.927231	9.799997	10.200003	45
20	9.728227	9.926831	9.801396	10.198604	40
25	9.729223	9.926431	9.802792	10.197208	35
30	9.720217	9.926029	9.804187	10.195813	30
35	9.731206	9.925626	9.805580	10.194420	25
40	9.732193	9.925222	9.806971	10.193029	20
45	9.733177	9.924816	9.808361	10.191639	15
50	9.734157	9.924409	9.809748	10.190252	10
55	9.735135	9.924001	9.811134	10.188866	5
60	9.736109	9.923591	9.812517	10.187483	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

57.

33.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.736109	9.923591	9.812517	10.187483	60
5	9.737080	9.923181	9.813899	10.186101	55
10	9.738048	9.922769	9.815280	10.184720	50
15	9.739013	9.922355	9.816658	10.183342	45
20	9.739975	9.921940	9.818035	10.181965	40
25	9.740934	9.921524	9.819410	10.180590	35
30	9.741889	9.921107	9.820783	10.179217	30
35	9.742842	9.920688	9.822154	10.177846	25
40	9.743792	9.920268	9.823524	10.176476	20
45	9.744739	9.919846	9.824893	10.175107	15
50	9.745683	9.919424	9.826259	10.173741	10
55	9.746624	9.919000	9.827624	10.172376	5
60	9.747562	9.918574	9.828987	10.171013	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

56.

34.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9·747562	9·918574	9.828987	10.171013	60
5	9·748497	9·918147	9.830349	10.169651	55
10	9·749429	9·917719	9.831709	10.168291	50
15	9·750358	9·917290	9.833068	10.166932	45
20	9·751284	9·916859	9.834425	10.165575	40
25	9·752208	9·916427	9.835780	10.164220	35
30	9·753128	9·915994	9.837134	10.162866	30
35	9·754046	9·915559	9.838487	10.161513	25
40	9·754960	9·915123	9.839838	10.160162	20
45	9·755872	9·914685	9.841187	10.158813	15
50	9·756782	9·914246	9.842535	10.157465	10
55	9·757688	9·913806	9.843882	10.156118	5
60	9·758591	9·913365	9.845227	10.154773	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

55.

35.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9·758591	9·913365	9.845227	10.154773	60
5	9·759492	9·912922	9:846570	10.153430	55
10	9·760390	9·912477	9.847913	10.152087	50
15	9·761285	9·912031	9.849254	10.150746	45
20	9·762177	9·911584	9.850593	10.149407	40
25	9·763067	9·911136	9.851931	10.148069	35
30	9·763954	9·910686	9.853268	10.146732	30
35	9·764838	9·910235	9.854603	10.145397	25
40	9·765720	9·909782	9.855938	10.144062	20
45	9·766598	9·909328	9.857270	10.142730	15
50	9·767475	9·908873	9.858602	10.141398	10
55	9·768348	9·908416	9.859932	10.140068	5
60	9·769219	9·907958	9.861261	10.138739	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

54.

36.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.769219	9.907758	9.861261	10.138739	60
5	9.770087	9.907498	9.862589	10.137411	55
10	9.770952	9.907037	9.863915	10.136085	50
15	9.771815	9.906575	9.865240	10.134760	45
20	9.772675	9.906111	9.866564	10.133436	40
25	9.773533	9.905645	9.867887	10.132133	35
30	9.774388	9.905179	9.869209	10.130791	30
35	9.775240	9.904711	9.870529	10.129471	25
40	9.776090	9.904241	9.871849	10.128151	20
45	9.776937	9.903770	9.873167	10.126833	15
50	9.777781	9.903298	9.874484	10.125561	10
55	9.778624	9.902824	9.875800	10.124200	5
60	9.779463	9.902349	9.877114	10.122886	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

53.

37.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.779463	9.902349	9.877114	10.122886	60
5	9.780300	9.901872	9.878428	10.121572	55
10	9.781134	9.901394	9.879741	10.120259	50
15	9.781966	9.900914	9.881052	10.118948	45
20	9.782796	9.900433	9.882363	10.117637	40
25	9.783623	9.899951	9.883672	10.116328	35
30	9.784447	9.899467	9.884980	10.115020	30
35	9.785269	9.898981	9.886288	10.113712	25
40	9.786089	9.898494	9.887594	10.112406	20
45	9.786906	9.898006	9.888900	10.111100	15
50	9.787720	9.897516	9.890204	10.109796	10
55	9.788532	9.897025	9.891507	10.108493	5
60	9.789342	9.896530	9.892810	10.107190	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

52.

38.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.789342	9.896532	9.892810	10.107190	60
5	9.790149	9.896038	9.894111	10.105889	55
10	9.790954	9.895542	9.895412	10.104588	50
15	9.791757	9.895045	9.896712	10.103288	45
20	9.792557	9.894546	9.898010	10.101990	40
25	9.793354	9.894046	9.899308	10.100692	35
30	9.794150	9.893544	9.900605	10.099395	30
35	9.794942	9.893041	9.901901	10.098099	25
40	9.795733	9.892536	9.903197	10.096803	20
45	9.796521	9.892030	9.904491	10.095509	15
50	9.797307	9.891523	9.905785	10.094215	10
55	9.798091	9.891013	9.907077	10.092923	5
60	9.798872	9.890503	9.908369	10.091631	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

51.

39.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.798872	9.890503	9.908369	10.091631	60
5	9.799651	9.889990	9.909660	10.090340	55
10	9.800427	9.889477	9.910951	10.089049	50
15	9.801201	9.888961	9.912240	10.087760	45
20	9.801973	9.888444	9.913529	10.086471	40
25	9.802743	9.887926	9.914817	10.085183	35
30	9.803511	9.887406	9.916104	10.083895	30
35	9.804276	9.886885	9.917391	10.082609	25
40	9.805039	9.886362	9.918677	10.081323	20
45	9.805799	9.885837	9.919962	10.080038	15
50	9.806557	9.885311	9.921247	10.078753	10
55	9.807314	9.884783	9.922530	10.077470	5
60	9.808067	9.884254	9.923814	10.076186	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

50.

40.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.808067	9.884254	9.923814	10.076186	60
5	9.808819	9.883723	9.925096	10.074904	55
10	9.809569	9.883191	9.926378	10.073622	50
15	9.810316	9.882657	9.927659	10.072341	45
20	9.811061	9.882121	9.928940	10.071060	40
25	9.811804	9.881584	9.930220	10.069780	35
30	9.812544	9.881046	9.931499	10.068501	30
35	9.813283	9.880505	9.932778	10.067222	25
40	9.814019	9.879963	9.934056	10.065944	20
45	9.814753	9.879420	9.935333	10.064667	15
50	9.815485	9.878875	9.936611	10.063389	10
55	9.816215	9.878328	9.937887	10.062113	5
60	9.816943	9.877780	9.939163	10.060837	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

49.

41.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.816943	9.877780	9.939163	10.060837	60
5	9.817668	9.877230	9.940439	10.059561	55
10	9.818392	9.876678	9.941713	10.058287	50
15	9.819113	9.876125	9.942988	10.057012	45
20	9.819832	9.875571	9.944262	10.055738	40
25	9.820550	9.875014	9.945535	10.054465	35
30	9.821265	9.874456	9.946808	10.053192	30
35	9.821977	9.873896	9.948081	10.051919	25
40	9.822688	9.873335	9.949353	10.050647	20
45	9.823397	9.872772	9.950625	10.049375	15
50	9.824104	9.872208	9.951896	10.048104	10
55	9.824808	9.871641	9.953167	10.046833	5
60	9.825511	9.871073	9.954437	10.045563	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

48.

42.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.825511	9.871073	9.954437	10.045503	60
5	9.826211	9.870504	9.955708	10.044292	55
10	9.826910	9.869933	9.956977	10.043023	50
15	9.827606	9.869360	9.958247	10.041753	45
20	9.828301	9.868785	9.959516	10.040484	40
25	9.828993	9.868209	9.960784	10.039216	35
30	9.829683	9.867631	9.962052	10.037948	30
35	9.830372	9.867051	9.963320	10.036680	25
40	9.831058	9.866470	9.964588	10.035412	20
45	9.831742	9.865887	9.965855	10.034145	15
50	9.832425	9.865302	9.967123	10.032877	10
55	9.833105	9.864716	9.968389	10.031611	5
60	9.833783	9.864127	9.969656	10.030344	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

47.

43.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.833783	9.864127	9.969656	10.030344	60
5	9.834460	9.863538	9.970922	10.029078	55
10	9.835134	9.862946	9.972188	10.027812	50
15	9.835807	9.862353	9.973454	10.026546	45
20	9.836377	9.861758	9.974720	10.025280	40
25	9.837146	9.861161	9.975985	10.024015	35
30	9.837812	9.860562	9.977250	10.022750	30
35	9.838477	9.859962	9.978515	10.021485	25
40	9.839140	9.859360	9.979780	10.020220	20
45	9.839800	9.858756	9.981044	10.018956	15
50	9.840459	9.858151	9.982309	10.017691	10
55	9.841116	9.857543	9.983573	10.016427	5
60	9.841771	9.856934	9.984837	10.015163	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

46.

44.

M	Sine.	Co-ſine.	Tangent.	Co-tang.	
0	9.841771	9.856934	9.984837	10.015163	60
5	9.842424	9.856323	9.986101	10.013899	55
10	9.843076	9.855711	9.987365	10.012635	50
15	9.843725	9.855096	9.988629	10.011371	45
20	9.844372	9.854480	9.989893	10.010107	40
25	9.845018	9.853862	9.991156	10.008844	35
30	9.845662	9.853242	9.992420	10.007580	30
35	9.846304	9.852620	9.993683	10.006317	25
40	9.846944	9.851997	9.994947	10.005053	20
45	9.847582	9.851372	9.996210	10.003790	15
50	9.848218	9.850745	9.997473	10.002527	10
55	9.848852	9.850116	9.998737	10.001263	5
60	9.849485	9.849485	10.00000	10.000000	0
	Co-ſine.	Sine.	Co-tang.	Tangent.	M

45.

A
TABLE
OF
Logarithm Numbers.

A Table of Logarithms.

N.	Logarith.	N.	Logarith.	N.	Logarith.
1	0.000000	34	1.531479	67	1.826075
2	0.301030	35	1.544068	68	1.832509
3	0.477121	36	1.556303	69	1.838849
4	0.602060	37	1.568202	70	1.845098
5	0.698970	38	1.579783	71	1.851258
6	0.778151	39	1.591064	72	1.857332
7	0.845098	40	1.602060	73	1.863323
8	0.903090	41	1.612784	74	1.869232
9	0.954242	42	1.623249	75	1.875061
10	1.000000	43	1.633468	76	1.880813
11	1.041393	44	1.643452	77	1.886491
12	1.079181	45	1.653212	78	1.892094
13	1.113943	46	1.662758	79	1.897627
14	1.146128	47	1.672098	80	1.903090
15	1.176091	48	1.681241	81	1.908485
16	1.204120	49	1.690196	82	1.913814
17	1.230449	50	1.698970	83	1.919078
18	1.255272	51	1.707570	84	1.924279
19	1.278753	52	1.716003	85	1.929419
20	1.301230	53	1.724276	86	1.934498
21	1.322219	54	1.732394	87	1.939519
22	1.342422	55	1.740362	88	1.944482
23	1.361728	56	1.748188	89	1.949390
24	1.380211	57	1.755875	90	1.954242
25	1.397940	58	1.763428	91	1.959041
26	1.414973	59	1.770852	92	1.963788
27	1.431364	60	1.778151	93	1.968483
28	1.447158	61	1.785330	94	1.973128
29	1.462398	62	1.792391	95	1.977723
30	1.477121	63	1.799340	96	1.982271
31	1.491361	64	1.806180	97	1.986772
32	1.505150	65	1.812913	98	1.991226
33	1.518514	66	1.819544	99	1.995635
34	1.531479	67	1.826075	100	2.000000

N.	Logarith.	N.	Logarith.	N.	Logarith.
101	2.004321	134	2.127105	167	2.222716
102	2.008600	135	2.130334	168	2.225309
103	2.012837	136	2.133539	169	2.227887
104	2.017033	137	2.136721	170	2.230449
105	2.021189	138	2.139879	171	2.232996
106	2.025306	139	2.143015	172	2.235528
107	2.029384	140	2.146128	173	2.238046
108	2.033424	141	2.149219	174	2.240549
109	2.037426	142	2.152288	175	2.243038
110	2.041393	143	2.155336	176	2.245513
111	2.045323	144	2.158362	177	2.247973
112	2.049218	145	2.161368	178	2.250420
113	2.053078	146	2.164353	179	2.252853
114	2.056905	147	2.167317	180	2.255273
115	2.060698	148	2.170262	181	2.257679
116	2.064458	149	2.173186	182	2.260071
117	2.068186	150	2.176091	183	2.262451
118	2.071882	151	2.178977	184	2.264818
119	2.075547	152	2.181844	185	2.267172
120	2.079181	153	2.184691	186	2.269513
121	2.082785	154	2.187521	187	2.271842
122	2.086359	155	2.190332	188	2.274158
123	2.089905	156	2.193125	189	2.276462
124	2.093422	157	2.195899	190	2.278754
125	2.096910	158	2.198657	191	2.281033
126	2.100371	159	2.201397	192	2.283301
127	2.103804	160	2.204110	193	2.285557
128	2.107209	161	2.206826	194	2.287802
129	2.110589	162	2.209515	195	2.290035
130	2.113943	163	2.212187	196	2.292256
131	2.117271	164	2.214844	197	2.294466
132	2.120574	165	2.217484	198	2.296665
133	2.123852	166	2.220108	199	2.298853
134	2.127105	167	2.222716	200	2.301029

N.	Logarith.	N.	Logarith.	N.	Logarith.
201	2.303196	234	2.369216	267	2.426511
202	2.305351	235	2.371068	268	2.428135
203	2.307496	236	2.372912	269	2.429752
204	2.309630	237	2.374748	270	2.421364
205	2.311754	238	2.376577	271	2.432969
206	2.313867	239	2.378398	272	2.434569
207	2.315970	240	2.380211	273	2.436163
208	2.318063	241	2.382017	274	2.437751
209	2.320146	242	2.383815	275	2.439338
210	2.322219	243	2.385606	276	2.440909
211	2.324282	244	2.387389	277	2.442479
212	2.326336	245	2.389166	278	2.444045
213	2.328379	246	2.390935	279	2.445604
214	2.330414	247	2.392697	280	2.447158
215	2.332438	248	2.394452	281	2.448706
216	2.334454	249	2.396199	282	2.450249
217	2.336459	250	2.397940	283	2.451786
218	2.338456	251	2.399674	284	2.453318
219	2.340444	252	2.401401	285	2.454845
220	2.342422	253	2.403121	286	2.456366
221	2.344392	254	2.404834	287	2.457889
222	2.346353	255	2.406540	288	2.459392
223	2.348305	256	2.408239	289	2.460898
224	2.350248	257	2.409938	290	2.462398
225	2.352183	258	2.411619	291	2.463893
226	2.354108	259	2.413299	292	2.465383
227	2.356026	260	2.414973	293	2.466868
228	2.357936	261	2.416641	294	2.468347
229	2.359835	262	2.418301	295	2.469822
230	2.361728	263	2.419956	296	2.471292
231	2.363612	264	2.421604	297	2.472756
232	2.365488	265	2.423246	298	2.474216
233	2.367356	266	2.424882	299	2.475671
234	2.369216	267	2.426511	300	2.477121

N.	Logarith.	N.	Logarith.	N.	Logarith.
301	2.478566	334	2.523746	367	2.564666
302	2.480007	335	2.525045	368	2.565848
303	2.481443	336	2.526339	369	2.567026
304	2.482874	337	2.527629	370	2.568202
305	2.484299	338	2.528916	371	2.569374
306	2.485721	339	2.530199	372	2.570543
307	2.487138	340	2.531479	373	2.571709
308	2.488551	341	2.532754	374	2.572872
309	2.489958	342	2.534026	375	2.574031
310	2.491362	343	2.535294	376	2.575188
311	2.492760	344	2.536558	377	2.576341
312	2.494155	345	2.537819	378	2.577492
313	2.495544	346	2.539076	379	2.578639
314	2.496929	347	2.540329	380	2.579784
315	2.498311	348	2.541579	381	2.580925
316	2.499687	349	2.542825	382	2.582063
317	2.501059	350	2.544008	383	2.583199
318	2.502427	351	2.545307	384	2.584331
319	2.503791	352	2.546543	385	2.585461
320	2.505149	353	2.547775	386	2.586587
321	2.506505	354	2.549003	387	2.587711
322	2.507856	355	2.550228	388	2.588832
323	2.509203	356	2.551449	389	2.589949
324	2.510545	357	2.552668	390	2.591065
325	2.511883	358	2.553883	391	2.592177
326	2.513218	359	2.555094	392	2.593286
327	2.514548	360	2.556303	393	2.594393
328	2.515874	361	2.557507	394	2.595496
329	2.517196	362	2.558709	395	2.596597
330	2.518514	363	2.559907	396	2.597695
331	2.519828	364	2.561101	397	2.598790
332	2.521138	365	2.562293	398	2.599883
333	2.522444	366	2.563481	399	2.600973
334	2.523746	367	2.564666	400	2.602060

N.	Logarith.	N.	Logarith.	N.	Logarith.
401	2.603144	434	2.637489	467	2.669317
402	2.604226	435	2.638489	468	2.670246
403	2.605305	436	2.639486	469	2.671173
404	2.606381	437	2.640481	470	2.672098
405	2.607455	438	2.641475	471	2.673021
406	2.608526	439	2.642465	472	2.673942
407	2.609594	440	2.643453	473	2.674861
408	2.610660	441	2.644439	474	2.675778
409	2.611723	442	2.645422	475	2.676694
410	2.612784	443	2.646404	476	2.677607
411	2.613842	444	2.647383	477	2.678518
412	2.614897	445	2.648360	478	2.679428
413	2.615950	446	2.649335	479	2.680336
414	2.617000	447	2.650308	480	2.681241
415	2.618048	448	2.651278	481	2.682145
416	2.619093	449	2.652246	482	2.683047
417	2.620136	450	2.653213	483	2.683947
418	2.621176	451	2.654177	484	2.684845
419	2.622214	452	2.655138	485	2.685742
420	2.623249	453	2.656098	486	2.686636
421	2.624282	454	2.657056	487	2.687529
422	2.625312	455	2.658011	488	2.688419
423	2.626340	456	2.658965	489	2.689309
424	2.627366	457	2.659916	490	2.690196
425	2.628389	458	2.660865	491	2.691081
426	2.629409	459	2.661813	492	2.691965
427	2.630428	460	2.662758	493	2.692847
428	2.631444	461	2.663701	494	2.693727
429	2.632457	462	2.664642	495	2.694605
430	2.633468	463	2.665581	496	2.695482
431	2.634477	464	2.666518	497	2.696356
432	2.635484	465	2.667453	498	2.697229
433	2.636488	466	2.668386	499	2.698101
434	2.637489	467	2.669317	500	2.698970

N.	Logarith.	N.	Logarith.	N.	Logarith.
501	2.699838	534	2.727541	567	2.753583
502	2.700704	535	2.728354	568	2.754348
503	2.701568	536	2.729165	569	2.755112
504	2.702430	537	2.729974	570	2.755875
505	2.703291	538	2.730782	571	2.756636
506	2.704151	539	2.731589	572	2.757396
507	2.705008	540	2.732394	573	2.758155
508	2.705863	541	2.733197	574	2.758912
509	2.706718	542	2.733999	575	2.759668
510	2.707570	543	2.734799	576	2.760422
511	2.708421	544	2.735599	577	2.761176
512	2.709269	545	2.736397	578	2.761928
513	2.710117	546	2.737192	579	2.762679
514	2.710963	547	2.737987	580	2.763428
515	2.711807	548	2.738781	581	2.764176
516	2.712649	549	2.739572	582	2.764923
517	2.713491	550	2.740363	583	2.765669
518	2.714329	551	2.741152	584	2.766413
519	2.715167	552	2.741939	585	2.767156
520	2.716003	553	2.742725	586	2.767898
521	2.716838	554	2.743509	587	2.708638
522	2.717671	555	2.744293	588	2.769377
523	2.718502	556	2.745075	589	2.770115
524	2.719331	557	2.745855	590	2.770852
525	2.720159	558	2.746634	591	2.771587
526	2.720986	559	2.747412	592	2.772322
527	2.721811	560	2.748188	593	2.773055
528	2.722634	561	2.748963	594	2.773786
529	2.723456	562	2.749736	595	2.774517
530	2.724276	563	2.750508	596	2.775246
531	2.725095	564	2.751279	597	2.775974
532	2.725912	565	2.752048	598	2.776701
533	2.726727	566	2.752816	599	2.777427
534	2.727541	567	2.753583	600	2.778151

N.	Logarith.	N.	Logarith.	N.	Logarith.
601	2.778874	634	2.802089	667	2.824126
602	2.779596	635	2.802774	668	2.824776
603	2.780317	636	2.803457	669	2.825426
604	2.781037	637	2.804139	670	2.826075
605	2.781755	638	2.804821	671	2.826723
606	2.782473	639	2.805501	672	2.827369
607	2.783189	640	2.806179	673	2.828015
608	2.783904	641	2.806858	674	2.828659
609	3.784617	642	2.807535	675	2.829304
610	2.785329	643	2.808211	676	2.829947
611	2.786041	644	2.808886	677	2.830589
612	2.786751	645	2.809559	678	2.831229
613	2.787460	646	2.810233	679	2.831869
614	2.788164	647	2.810904	680	2.832509
615	2.788875	648	2.811575	681	2.833147
616	2.789581	649	2.812245	682	2.833784
617	2.790285	650	2.812913	683	2.834421
618	2.790988	651	2.813581	684	2.835056
619	2.791691	652	2.814248	685	2.835691
620	2.792302	653	2.814913	686	2.836324
621	2.793092	654	2.815578	687	2.836957
622	2.793791	655	2.816241	688	2.837588
623	2.794488	656	2.816904	689	2.838219
624	2.795185	657	2 817565	690	2.838849
625	2.795880	658	2.818226	691	2.839478
626	2.796574	659	2.818885	692	2.840106
627	2.797268	660	2.819543	693	2.840733
628	2.797959	661	2.820201	694	2.841359
629	2.798651	662	2.820858	695	2.841985
630	2.799341	663	2.821514	696	2.842609
631	2.800029	664	2.822168	697	2.843233
632	2.800717	665	2.822822	698	2.843855
633	2.801404	666	2.823474	699	2.844477
634	2.802080	667	2.824126	700	2.845098

700

N.	Logarith.	N.	Logarith.	N.	Logarith.
701	2.845718	734	2.865696	767	2.884795
702	2.846337	735	2.866287	768	2.885361
703	2.846955	736	2.866878	769	2.885926
704	2.847573	737	2.867467	770	2.886491
705	2.848189	738	2.868056	771	2.887054
706	2.848805	739	2.868643	772	2.887617
707	2.849419	740	2.869232	773	2.888179
708	2.850033	741	2.869818	774	2.888741
709	2.850646	742	2.870404	775	2.889302
710	2.851258	743	2.870989	776	2.889862
711	2.851869	744	2.871573	777	2.890421
712	2.852479	745	2.872156	778	2.890979
713	2.853089	746	2.872739	779	2.891537
714	2.853698	747	2.873321	780	2.892095
715	2.854306	748	2.873902	781	2.892651
716	2.854913	749	2.874482	782	2.893207
717	2.855519	750	2.875061	783	2.893762
718	2.856124	751	2.875639	784	2.894316
716	2.856729	752	2.876218	785	2.894869
720	2.857332	753	2.876795	786	2.895423
721	2.857935	754	2.877371	787	2.895975
722	2.858537	755	2.877947	788	2.896526
723	2.859138	756	2.878522	789	2.897077
724	2.859739	757	2.879096	790	2.897627
725	2.860338	758	2.879669	791	2.898176
726	2.860937	759	2.880242	792	2.898725
727	2.861534	760	2.880814	793	2.899273
728	2.862131	761	2.881385	794	2.899821
729	2.862728	762	2.881955	795	2.900367
730	2.863323	763	2.882525	796	2.900913
731	2.863917	764	2.883093	797	2.901458
732	2.864511	765	2.883661	798	2.902003
733	2.865104	766	2.884229	799	2.902547
734	2.865696	767	2.884795	800	2.903089

N.	Logarith.	N.	Logarith.	N.	Logarith.
801	2.903633	834	2.921166	867	2.938019
802	2.904174	835	2.921686	868	2.938519
803	2.904716	836	2.922206	869	2.939019
804	2.905256	837	2.922725	870	2.939519
805	2.905796	838	2.923244	871	2.940018
806	2.906335	839	2.923762	872	2.940516
807	2.906874	840	2.924279	873	2.941014
808	2.907411	841	2.924796	874	2.941511
809	2.907949	842	2.925312	875	2.942008
810	2.908485	843	2.925828	876	2.942504
811	2.909021	844	2.926342	877	2.942999
812	2.909556	845	2.926857	878	2.943495
813	2.910091	846	2.927370	879	2.943989
814	2.910624	847	2.927883	880	2.944483
815	2.911158	848	2.928396	881	2.944976
816	2.911690	849	2.928908	882	2.945468
817	2.912222	850	2.929419	883	2.945961
818	2.912753	851	2.929929	884	2.946452
819	2.913284	852	2.930439	885	2.946943
820	2.913814	853	2.930949	886	2.947434
821	2.914343	854	2.931458	887	2.947924
822	2.914872	855	2.931966	888	2.948413
823	2.915399	856	2.932474	889	2.948902
824	2.915927	857	2.932981	890	2.949390
825	2.916454	858	2.933487	891	2.940878
826	2.916980	859	2.933993	892	2.950365
827	2.917506	860	2.934498	893	2.950851
828	2.918030	861	2.935003	894	2.951338
829	2.918555	862	2.935507	895	2.951823
830	2.919078	863	2.936011	896	2.952308
831	2.919601	864	2.936514	897	2.952792
832	2.920123	865	2.937016	898	2.953276
833	2.920645	866	2.937518	899	2.953759
834	2.921166	867	2.938019	900	2.954243

N.	Logarith.	N.	Logarith.	N.	Logarith.
901	2.954725	934	2.970347	967	2.985426
902	2.955207	935	2.970812	968	2.985875
903	2.955688	936	2.971276	969	2.986324
904	2.956168	937	2.971739	970	2.986772
905	2.956649	938	2.972203	971	2.987219
906	2.957128	939	2.972666	972	2.987666
907	2.957607	940	2.973128	973	2.988113
908	2.958086	941	2.973589	974	2.988559
909	2.958564	942	2.974050	975	2.989005
910	2.959041	943	2.974512	976	2.989449
911	2.959518	944	2.974972	977	2.989895
912	2.959995	945	2.975432	978	2.99[illegible]339
913	2.960471	946	2.975891	979	2.99[illegible]783
914	2.960946	947	2.976349	980	2.99[illegible]226
915	2.961421	948	2.976808	981	2.991669
916	2.961895	949	2.977266	982	2.992111
917	2.962369	950	2.977724	983	2.992554
918	2.962843	951	2.978181	984	2.992995
919	2.963315	952	2.978637	985	2.993436
920	2.963788	953	2.979093	986	2.993877
921	2.964259	954	2.979548	987	2.994317
922	2.964731	955	2.980003	988	2.994756
923	2.965202	956	2.980458	989	2.995196
924	2.965672	957	2.980912	990	2.995635
925	2.966142	958	2.981366	991	2.996074
926	2.966611	959	2.981819	992	2.996512
927	2.967079	960	2.982271	993	2.996949
928	2.967548	961	2.982723	994	2.997386
929	2.968016	962	2.983175	995	2.997823
930	2.968483	963	2.983626	996	2.998250
931	2.968949	964	2.984077	997	2.998695
932	2.969416	965	2.984527	998	2.999130
933	2.969882	966	2.984977	999	2.999560
934	2.970347	967	2.985426	1000	3.000000

THE Uſe of theſe TABLES hath been already at large ſhewed in the Firſt and Twelfth Chapters; therefore I ſhall ſay no more of them here.

AN

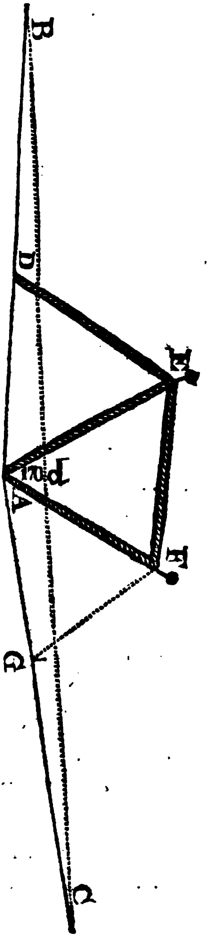
APPENDIX,

Shewing farther

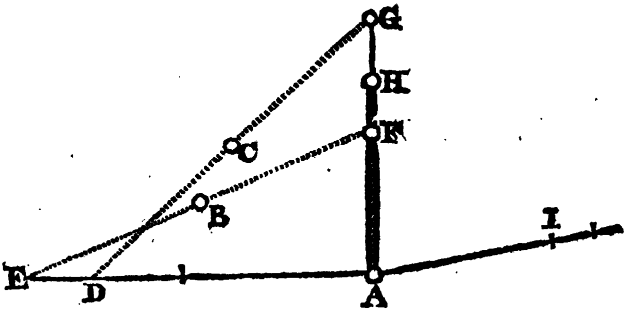
How to ſurvey by the Chain only: With an uſeful Table to that purpoſe.

HAVING, in the ſixth Chapter of the foregoing Treatiſe, taught a ready and eaſy Way for taking the Quantity of an Angle in the Field by the Chain only; and underſtanding it to have met with good Acceptance among Surveyors and others: I thought it proper to ſay ſomething more on that Subject, the preſent Opportunity of a new Edition of the Book inviting me thereto. And that this Way of working may be practiſed as quick and true as any in the World, with all the coſtly Inſtruments that ever were invented, there are two ſeeming Difficulties to be removed. The *firſt* is, when the Angle grows very obtuſe, that is to ſay, containing 170 Degrees or more, then the Subtendent or Chord-Line will hardly be diſtinguiſhable between five or ſix Degrees, there being but $\frac{1}{3}$ Part of a Link difference between 170 Deg. and 171 Degrees, and not above $\frac{1}{10}$ Part, between 178 and 179 Degrees. To remedy which, you need not take the Quantity of that Angle at all, eſpecially if it be an inward Angle, but meaſure directly from *B* to *C*; and when you come right againſt *A*, take an Off-ſet (which you may do with a Rod or Line alone, as true as with a

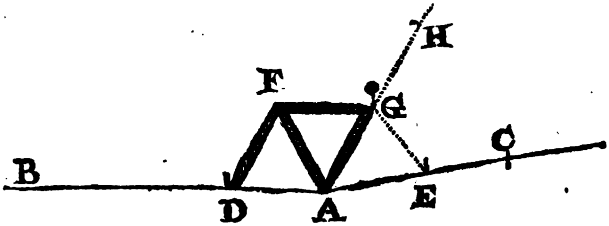
Croſs or other Inſtrument) which Off-ſet, put down in your Field-Book, will do the Buſineſs when you come to protract, as well as if you had taken the Angle in the Field: But if that does not pleaſe you, or any other Reaſon neceſſitate you to take the Angle *A*, there place a ſtrong Stick in the very Angle *A*, and putting the Ring of the Chain over it, ſtretch it out at full length, both in the Line *AB* and *AC*; and where the End of the Chain falls, there place Sticks alſo, as at *D* and *G*. Remove your Chain from *A*, and put the Ring over the Stick at *D*, and ſtretch it out at adventure as towards *E*. Now you ſhould have another Chain, or a ſmall Line, (which you may carry in your Pocket) exactly of the length of a Chain, with a Loop at each End; which put over the Stick at *A*, and taking the other Loop of the Line in one Hand, and the looſe End of the Chain in the other Hand, go backward, till both being ſtretched ſtrait meet at *E*, then have you found *DAE*, an Equilateral Triangle conſiſting of 60 Degrees; to which add another Equilateral Triangle by looſing the Chain at *D*, and putting it over the Stick at *E*, letting the Line remain as it was faſtened at *A*, and taking the looſe Ends again of the Chain and Line in your Hands, go backwards as before, until both being ſtretched ſtrait, meet in *F*. So have you found two Equilateral Triangles, or 120 Degrees. Laſtly, With your Chain meaſure the neareſt Diſtance *FG*, which ſuppoſe to be 84 Links and a half; which Sum look for in the following Table, and right againſt it you will find 50 Degrees, which added to 120, make 170 Degrees, the Quantity of the Angle



Angle ſought; or if you have not a Mind to uſe the Table, you may note it down in your Field-Book, thus, △ △ $84\frac{1}{5}$, ſignifying that Angle conſiſts of two Equilaterals and $84\frac{1}{5}$ Links for its Subtendent; and you may plot it, by doing with your Compaſſes upon the Paper, what you did in the Field with the Chain. But now perhaps you may be ready to ſay, you pretend to teach how to take the Quantity of an obtuſe Angle with the Chain only, and here is a Line required, or two Chains at leaſt. Well then, you ſhall preſently ſee how to do it with one Chain only Let *EAI*, in the following Figure, be the Angle of 170 Degrees; meaſure from *A* towards *B* and *C*, half a Chain on each Side, as to *D* and *E*, where ſtick down Sticks, and one at *A*; then put the Ring at one End of the Chain over the Stick at *A*, and the other End over the Stick at *D*, and taking the Chain in the middle by the Ring that is commonly at the End of 50 Links, go backwards till both Parts are ſtrait, and there ſtick down a Stick, as at *F*. Then looſe the Ring from *D*, and put it over the Stick at *F*, and taking the very middle of the Chain, make both Parts ſtrait, which they will be at *C*, where ſtick down a Stick, from which meaſure to *E*, noting it down in your Field-Book △ △ $42\frac{1}{5}$, and when you plot it, remember to make your Equilaterals but of 50 Links the Sides of them: I ſay, when you plot it; for you may not in this Caſe have recourſe to the following Table, that being made to the



Radius of 100 Links, unleſs you double the Number of Links found between *C* and *E*; or, which is better, when you have finiſh'd your two Equilaterals, one End of the Chain hanging at *A*, ſtretch the other at full Length over the Stick at *G*, which will fall at *H*; then meaſuring the neareſt Diſtance between *H* and *C*, you will find it to be 84 $\frac{1}{2}$ Links, againſt which in the Table ſtand 50 Degrees, which added to your two Equilaterals, make 170 Degrees for the Angle *A*. [*See this Figure.*]

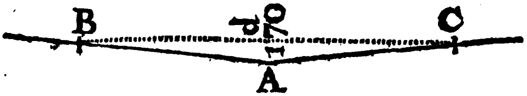


But now if you had rather meaſure this Angle, by firſt taking out a right Angle from it; thus you may do to find the Perpendicular for the right Angle: [*See the Figure on the other Side.*] Put one Ring of your Chain over the Stick at the Angle *A*, and ſtretching out the Chain, let the other End fall any where at adventure, as at *B* or *C*; where ſtick a Stick through the Ring, and looſing that End at *A*, take it in your Hand, and ſtretching it ſtrait, ſee in what Part it will juſt touch the Hedge *A E*; which will be at *D*, if the other End be at *C*; or at *E*, if the other End be at *B*; and there make a Mark; which done, keeping the End of your Chain in your Hand, go backward from *B* or *C*, towards *G* or *F*, till your Chain is ſtrait; then moving yourſelf ſideways to and fro, till you perceive your Chain to lie in a ſtrait Line with *B E* or *C D*, at the End of it place a Stick, at at *F* or *G*, from whence to *A* will be a Line perpendicular to *A E*; wherefore from *A* ſet off one Chain in that Line, which will fall at *H*; and one Chain upon the Line *A I*, which falls at *I*; and meaſuring the Diſtance *H I*, you will find it 128 Links $\frac{5}{10}$ Parts of a Link, or 80 Degrees; which added to the right Angle, makes 170 Deg. which was the Angle required.

Otherwiſe you may take a right Angle, by fixing one End of the Chain in the Angle itſelf, and the other End at 40 Links Diſtance in the Hedge; then take 50 Links in one Hand, and 30 in the other, and ſtretch both Parts ſtrait, their Meeting will conſtitute a right Angle, according to the well known Axiom, that 3, 4, and 5 make a right-angled Triangle.

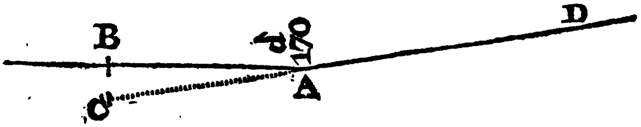
Many other Ways might be ſhewn, to take a right Angle in the Field by the Chain only, as alſo otherwiſe to meaſure the Quantity of an obtuſe Angle; but I omit them, leaving it to your own Practice and Ingenuity: Only one Way more, and the very beſt, to take the Quantity of this obtuſe Angle, which take as follows:

In the following Figure let *A* be the Angle required to be taken in the Field; by the Chain firſt from *A*, ſet off two Chains, one to *B*, the other to *C*; then fixing one End of the Chain in *B*, ſtretch the other direct in a ſtrait Line towards *C*, making a Mark where the End falls, which will be at 7; meaſure the Diſtance from 7 to *A*, which ſuppoſe to be 8 Links $\frac{7}{10}$ Parts of a Link; look in the following TABLE, and right againſt it you will find



5 Degrees; which doubled (the Angles *AC* 7 and *AB* 7 being equal, becauſe the Sides *AB* and *AC* are equal, and it) makes 10 Degrees; which ſubtracted from 180, leaves 170 for the deſired Angle at *A*.

But now if this had been an outward Angle, as we will ſuppoſe the following; you have no more to do, but to continue one Line; as for Example, the Line *DA* to *C*, one Chain, and alſo to ſet off one Chain upon the other Line from *A* to *B*; then meaſure the Diſtance *BC*, which



ſay to be 17 Links $\frac{4}{10}$ Parts of a Link, which anſwers in the Table to 10 Degrees, which is the Complement of the Angle *A* to 180 Degrees; wherefore take 10 from 180, remains 170 for the ſought outward Angle.

By this Time, I hope, the Difficulty of meaſuring obtuſe Angles is well removed, and the Matter made plain and eaſy: As for acute Angles, and ſuch obtuſe ones as are but a little bigger than 90 Degrees, you have the Way to meaſure them already in the ſixth Chapter of the foregoing Treatiſe, with ſundry Ways to meaſure a Field with the Chain only, to which I refer you.

It remains now to ſpeak of the ſecond ſeeming Difficulty, which lies in the Trouble of plotting after this Way: To remove which, you may have a Protractor made with Links on it inſtead of Degrees, or both, if you pleaſe; which the Inſtrument-maker may ſoon do by the Help of this Table. Or you may very well uſe your ordinary Protractors; for having a Copy of this Table in the Field with you, you may at once note down the Degrees of every Angle, without mentioning the Subtendents at all; or if you do only note down the Subtendents in your Field-book, when you come home, you may at once take all the Angles in Degrees anſwerable to them, and ſo plot with an ordinary Protractor, as at other Times. I have made the Table but to 140 Degrees; for as I told you before, when an Angle exceeds that, your beſt Way of meaſuring it, is as has been juſt now taught.

What has been already ſaid I preſume to be ſufficient to explain the following Table, and the Uſe thereof, therefore ſhall not trouble you with Repetitions; only deſire you to remember, that the Table is made for the Radius of one Chain, or 100 Links; and the Subtendents, or Chord Lines, are in Links, and decimal Parts of a Link: So that when you would uſe this Table, you muſt ſet off but one Chain from the Angle (you deſire to know the Quantity of) on either Hedge, and meaſuring the neareſt Diſtance between the two Ends of the Chains a-croſs from Hedge to Hedge, look for the Number of Links in the Table that neareſt Diſtance contains, and right againſt it you will find the Quantity of the Angle as true, if not truer, than if it had been taken by the beſt *Semicircle*, *Circumferentor*, or *Theodolite*.

EXAM-

EXAMPLE.

In Folio 113 of the foregoing Book, I would know the Quantity in Degrees of the Angle *e E e*, whoſe Subtendent is there (accounting one Chain Radius) ſaid to be 80 Links: Accordingly I look for 80 Links in the Table, and the neareſt Number to it is 79 Links $\frac{7}{10}$ Parts of a Link, and right againſt it ſtands 47 Degrees: Wherefore I ſay that Angle conſiſts of 47 Degrees, and a little more; and tho' it be needleſs, yet if you deſire to know how much that odd $\frac{3}{10}$ is (which is wanting to make up 80 Links) you may ſee by the Table, that in an Angle of this Bigneſs one Link and half raiſes a Degree; ſo that $\frac{3}{10}$ Parts of a Link is juſt 12 Minutes. The exact Angle therefore is 47°. 12'.

What has been ſaid concerning meaſuring a Field, or taking an Angle by the Chain only, either in the *Appendix*, or ſixth Chapter, may as well be applied to a Pole or Rod cut out of the Hedge, and divided into 100 equal Parts; and indeed you may altogether as well, and much quicker, do it with a Rod than the Chain, every Diviſion of the Rod anſwering to a Link of the Chain: But then you muſt take Care your Rod be ſtrait; and the Table ſerves as well for a Rod ſo divided as the Chain, only in caſting up there is a Difference (which your own Reaſon and the foregoing Treatiſe will ſufficiently explain to you) unleſs in meaſuring the Length of the Lines, you call every 4 Poles 1 Chain, and every 4 Diviſions of the Pole 1 Link; then you may caſt it as if it had been meaſured by the Chain: But there is no need for that, that I know of. You may have, I ſuppoſe, in *Crooked-Lane*, a Rod made to ſhoot one Part into another like a Fiſhing-rod, to be uſed as a Cane, in the Head whereof may be a ſmall Compaſs; which alone is Inſtrument enough to ſurvey any Piece of this Earth, be it Mannor or larger: And if ſo, what need is there of a Horſe-load of Braſs Circles and Semicircles, heavy Ball-Sockets, wooden Tables and Frames, and three-legged Staffs, *cum multis aliis*, unleſs to amuſe the ignorant Countryman, to make him more freely pay the Surveyor?

The TABLE *of Chords, or Subtendents to the Radius of one Chain of* Gunter's, *or* 100 *Links.*

Degrees.	Links.	Tenths of a Link.	Degrees.	Links.	Tenths.	Degrees.	Links.	Tenths.	Degrees.	Links.	Tenths.
1	1 .	7	36	61 .	8	71	116 .	1	106	159 .	7
2	3 .	5	37	63 .	4	72	117 .	5	107	160 .	8
3	5 .	2	38	65 .	1	73	119 .	0	108	161 .	8
4	7 .	0	39	66 .	8	74	120 .	4	109	162 .	8
5	8 .	7	40	68 .	4	75	121 .	8	110	163 .	8
6	10 .	5	41	70 .	0	76	123 .	1	111	164 .	8
7	12 .	2	42	71 .	7	77	124 .	5	112	165 .	8
8	14 .	0	43	73 .	3	78	125 .	9	113	166 .	8
9	15 .	7	44	74 .	9	79	127 .	2	114	167 .	7
10	17 .	4	45	76 .	5	80	128 .	5	115	168 .	7
11	19 .	2	46	78 .	2	81	129 .	9	116	169 .	6
12	20 .	9	47	79 .	7	82	131 .	2	117	170 .	5
13	22 .	6	48	81 .	3	83	132 .	5	118	171 .	4
14	24 .	4	49	82 .	9	84	133 .	8	119	172 .	3
15	26 .	1	50	84 .	5	85	135 .	1	120	173 .	2
16	27 .	8	51	86 .	1	86	136 .	4	121	174 .	1
17	29 .	6	52	87 .	7	87	137 .	7	122	174 .	9
18	31 .	3	53	89 .	2	88	139 .	0	123	175 .	7
19	33 .	0	54	90 .	8	89	140 .	2	124	176 .	6
20	34 .	7	55	92 .	3	90	141 .	4	125	177 .	4
21	36 .	4	56	93 .	9	91	142 .	6	126	178 .	2
22	38 .	2	57	95 .	4	92	143 .	8	127	179 .	0
23	39 .	9	58	97 .	0	93	145 .	0	128	179 .	8
24	41 .	6	59	98 .	5	94	146 .	2	129	180 .	5
25	43 .	3	60	100 .	0	95	147 .	4	130	181 .	3
26	44 .	9	61	101 .	5	96	148 .	6	131	182 .	0
27	46 .	7	62	103 .	0	97	149 .	8	132	182 .	7
28	48 .	4	63	104 .	5	98	151 .	0	133	183 .	4
29	50 .	1	64	106 .	0	99	152 .	1	134	184 .	0
30	51 .	8	65	107 .	4	100	153 .	2	135	184 .	7
31	53 .	4	66	108 .	9	101	154 .	3	136	185 .	4
32	55 .	1	67	110 .	4	102	155 .	4	137	186 .	1
33	56 .	8	68	111 .	8	103	156 .	5	138	186 .	7
34	58 .	5	69	113 .	3	104	157 .	6	139	187 .	3
35	60 .	1	70	114 .	7	105	158 .	7	140	187 .	9

F I N I S.